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ABSTRACT

Approximately 30 experiments related to environmental problems comprise this manual. The three conceptual themes under which these lessons are organized deal with: (1) change; (2) the interaction of custom, rule, and law in society; and (3) economy, life style, and individual attitudes. Provided are materials for both students and teachers. Teacher materials include background information, student objectives, references, and conceptual theme statement. Listed in the student materials are the problem, materials needed, procedure, discussion questions, and suggested follow-up experiments. (WB)

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10, 11, 12

Physical Sciences

I NTERDISCIPLINARY

D EVELOPMENT OF

E NVIRONMENTAL

A CTIVITIES AND

S OURCES

COMPILED BY THE FOLLOWING MEMBERS OF THE ENVIRONMENTAL
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FOREWORD

The next few decades will provide a challenge for both technology and our environment. Technology is charged primarily with solutions of our energy needs for transportation, electric power generation, and industrial plant operation. In the balance is our environment with many irreparable damages already begun. Will the next few years see harmony and balance between technology and environment or will one of these be predominant?

A technology dominated society will undoubtedly be relatively unconcerned about pollution of natural waters, destruction of forests by contamination of soils and preservation of wildlife. Technology alone may solve our basic energy problem while leaving a legacy of environmental destruction for the next generation.

An environmentally dominated society would preserve plants, animals and natural lands but at a severe cost to our modern life style. As acceptable "clean" energy sources are exhausted, less personal transportation would be feasible, many modern energy consuming conveniences would be curtailed and electric consumption would be limited.

The purpose of these IDEA packages in physical science is to make you more sensitive to the need for harmony and balance between these contrasting concepts. The key to the future is to find an acceptable technology that is sincerely concerned with preservation of our precious heritage: the environment.

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IDEAS

Conceptual Theme I (green)

All living things, including man, are interdependent with each other and with their environment.

Conceptual Theme II (canary yellow)

A living organism is the product of its heredity and its environment.

Conceptual Theme III (blue)

All living and non-living things are in a constant state of change; nothing is static.

Conceptual Theme IV (white)

Populations are affected by their environment and the environment is altered by the populations.

Conceptual Theme V (goldenrod)

Man's society is an interaction of custom, rule, and law.

Conceptual Theme VI (pink)

The economy and life style of a society results from the individual's attitude toward the use of natural resources.

Conceptual Theme VII (buff)

Man's sensitivity to and understanding of the total environment are essential for the well being of all life.

Appendix

Vocabulary

ENVIRONMENTAL EDUCATION PROGRAM - K-12

Philosophy

An organism, or a population of organisms, is the product of its heredity and its environment. This interaction between organisms and their environment is the basic concept governing all life on earth, including man. Therefore, it is essential to understand the basic concepts and how they can be interjected into our educational system.

Socially, environmentally, and biologically we are passing through a period unmatched in the history of our earth. Whole environments are being wiped out; species which have evolved over millions of years are being brought to the threshold of extinction. Communities and populations are going through unprecedented alteration; even man has not escaped. Eventually, man may be more affected than most other organisms.

Gradually, during the last decade man has seen a cultural change equal to the biological changes being brought about by the devastation of the environment. In the late 1960's for the first time in man's history, we saw a sudden awakening about the deteriorating quality of the environment.

Many important decisions are being made that will determine the outcome of struggle for space in which to live and play, air fit to breathe, water suitable to drink, food to feed our increasing populations, and fuels to fire industry and power plants. We are faced with an environmental quality that is rapidly deteriorating both from an aesthetic and physical stand-point. We are faced with an environment some question as suitable for life.

Why are we just now concerned? Is it new? When we look back into history, we find that the Greek, Roman, and British citizens were asking the same questions of their society as we are asking of ours. Men once lived in harmony with their environment, but today they are more interested in changing, modifying, controlling or dominating it rather than living with it. We pollute it with the products of our affluent society -- fertilizers, pesticides, wastes, and garbage.

As populations increase mathematically, environmental problems increase geometrically. We have an earth with finite resources -- water, land, air, natural resources, and space. Only through education can we develop a suitable life style, which will insure man's continued existence.

GOAL

The outcome of Polk County's Environmental Education Program is to produce a literate, action-oriented citizenry that is knowledgeable about the total environment and motivated to see realistic solutions to its problems. The program will be integrated into the existing curriculum, K-12, by employing an interdisciplinary approach coordinating the various disciplines.

OBJECTIVES

1. To develop an appreciation of and a sensitivity to the environment through the creation of a sense of awe for the natural world as an essential part of man.
2. To teach the value of life and a way of living in which destruction is kept to a minimum while relationships that enhance life are stressed, so that we may improve the quality of life without exploiting our natural resources.
3. To create an awareness of the environmental interrelationships, processes and problems so that in the future intelligent decisions will be made.
4. To emphasize that all organisms are products of their heredity and environment, thus determining the characteristics of a given population.
5. To realize that the behavior of an individual stems from an interaction of heredity as well as the physical, social and cultural environment.
6. To motivate the students to find and apply solutions to environmental problems by using methods that are suitable to the framework of our society.
7. To realize that government is an interaction of custom, rule, and law; and that governmental decisions affect our environment.

INTRODUCTION

Students should be provided with a direct encounter with their environment; they should be involved with it and experience it because students better understand activity-oriented experiences. They should begin with a project around their school, and then they can explore other off-campus environments. Emphasis should be placed on environmental education on the various phases at these levels of learning:

Primary - Awareness

Intermediate - Concern and Information

Secondary and Adults - Continue exploration with involvement or action

Materials have been reviewed from various counties in Florida, as well as from other states. The following materials were especially helpful in formulating our format:

1. People and Their Environment, Teacher's Curriculum Guide to Conservation Education, edited by Matthew J. Brennan. J. G. Ferguson Publishing Company.
2. Lee County Environmental Education Program, Title III E.S.E.A.
3. Brevard County, Broad Spectrum Environmental Education Program, Title III E.S.E.A.

EXPLANATION, USE AND FORMAT

Materials are divided into grade levels known as "clusters." Each cluster is organized into "conceptual themes." The conceptual themes, which will be color coded, are subdivided into generalizations called IDEAS. Each IDEAS consists of student-teacher materials.

An example of the format for Cluster Six follows:

Cluster Six - Sixth grade level of Interdisciplinary Development of Environmental Activities and Sources

Conceptual Theme I - All living things, including man, are interdependent with each other and with their environment.

IDEA A - All energy on earth comes from the sun.

IDEA B - Green plants convert light energy into food.

Seven major Conceptual Themes for Environmental IDEAS Cluster Four, Five, and Six have been developed to date. The seven themes and IDEAS listed will be utilized to some extent in all of the environmental education materials for Polk County. Additional IDEAS and activities may be developed.

Conceptual Themes:

- I - All living things, including man, are interdependent with each other and with their environment. (GREEN section)
- II - A living organism is the product of its heredity and its environment. (YELLOW section)
- III - All living and non-living things are in a constant state of change; nothing is static. (BLUE section)
- IV - Populations are affected by their environment, and the environment is altered by the population. (WHITE section)
- V - Man's society is an interaction of custom, rule, and law. (GOLDENROD section)
- VI - The economy and life style of a society results from the individual's attitude toward the use of natural resources. (PINK section)
- VII - Man's sensitivity to and understanding of the total environment are essential for the well being of all life. (BUFF section)

Conceptual Theme I

All living things, including man, are interdependent with each other and with their environment.

IDEA A - All energy on the earth comes from the sun.

IDEA B - Green plants convert light energy into food.

IDEA C - There is considerable variation of life in a small area.

IDEA D - Plants and animals live together and depend on each other.

IDEA E - No living thing (organism) lives alone.

IDEA F - Each organism has its own place (niche) in the ecosystem.

Conceptual Theme II

A living organism is the product of its heredity and its environment.

IDEA A - Environmental changes influence hereditary development through adaptive modifications.

IDEA B - Living things are adapted to their environment by structure and function through change.

IDEA C - Organisms vary in their tolerance to environmental conditions even within the same population.

IDEA D - A change in the organism's environment or in its hereditary traits may result in the death of the organism.

Conceptual Theme III

All living and non-living things are in a constant state of change; nothing is static.

IDEA A - Natural resources undergo continuous change.

IDEA B - All the matter and energy in the universe are constant; yet matter can be converted into energy and energy into matter.

IDEA C - The earth's surface is in a continuous state of change.

IDEA D - Natural communities, ecosystems, and the biosphere are in a constant state of change called succession.

IDEA E - Rapid environmental or hereditary changes may cause chain-reactions resulting in the extinction of or unwanted changes in organisms.

Conceptual Theme IV

Populations are affected by their environment, and the environment is altered by the population.

IDEA A - Natural environments are maintained by the organisms which live in them.

IDEA B - Man-made environments are maintained in a steady state through the continuous care and expenditures of energy by man.

IDEA C - Man-made environmental changes may change or destroy beneficial natural environments.

Conceptual Theme V

Man's society is an interaction of custom, rule and law.

IDEA A - Each individual has a vital role in helping maintain the environment so that it is suitable for all forms of life, including man.

IDEA B - Individuals are responsible for informing and influencing the decisions of law-makers so that they can make intelligent environmental decisions.

IDEA C - Environmental quality is defined and determined by society within the context of cultural, social, economic, and political values.

Conceptual Theme VI

The economy and life style of a society results from the individuals' attitudes toward technology and the use of natural resources.

IDEA A - The world's resources are limited, but the demands for these resources may be unlimited.

IDEA B - Man depends on natural resources for survival; his use or abuse of them determines his own fate, as well as the fate of his life support system -- "Spaceship Earth."

IDEA C - Natural resources and ecological systems have specific capabilities and limitations.

IDEA D - The rate of natural resources use depends largely on the conservation, economy, life style, population, and degree of industrialization of the nation.

Conceptual Theme VII

Man's sensitivity to and understanding of the total environment are essential for the well being of all life.

IDEA A - Man must appreciate the natural world for his own well being.

IDEA B - The creative arts are a means of expressing our sensitivity to the environment.

IDEA C - Our awareness of the environment may result in an appreciation of the creative arts.

IDEA D - The naturally occurring designs and uniqueness of nature provide unlimited creative opportunities.

IDEA E - Urban man needs the natural environment, not only as his life support system, but also for its therapeutic value through art, literature, music and recreation.

III. IDEA A-1

TEACHER MATERIALS

CONCEPTUAL THEME: III

All living and non-living things are in a constant state of change; nothing is static.

IDEA A:

Natural resources undergo continuous change.

BACKGROUND INFORMATION:

The process of distillation is one method of water purification. When water is boiled, it turns from a water solution to a pure vapor and may be recondensed as pure water.

Another method of water purification is filtration. Filtration methods work on suspended solids of relatively large size.

Two "contaminated" water samples could be prepared to illustrate two general different types of water pollutants; the "seen" and "un-seen". Solution one should contain a saturated solution of sodium chloride. Measurements are not necessary, however, don't add too much sodium chloride and cloud the water. The point is to emphasize the kind of contaminant that you cannot see. The second solution can be a mixture of garden soil and water.

The original solution and distillate can be visually checked for both solutions. Both the original and distillate for solution one will appear the same, but not to the taste! Further investigation will find the original solution to taste salty. Chemical evidence of salt can be shown with a dilute solution of silver nitrate. Drop several drops in both solutions. Note the precipitate or cloudiness present in the original.

The second solution can be visually compared for best results. The difference will be obvious; the distillate is certainly free of the debris.

Much more elaborate water analysis systems can be devised, but this might be a good starting point for water pollution studies.

PROCESS OR ACTIVITIES:

Observing, describing, predicting, comparing and inferring.

STUDENT OBJECTIVES:

- (1) Demonstrate the laboratory technique of distillation.
- (2) Develop a method of determining water purity.

III. IDEA A-1

STUDENT MATERIALS

PROBLEM:

How can we purify contaminated water.

MATERIALS:

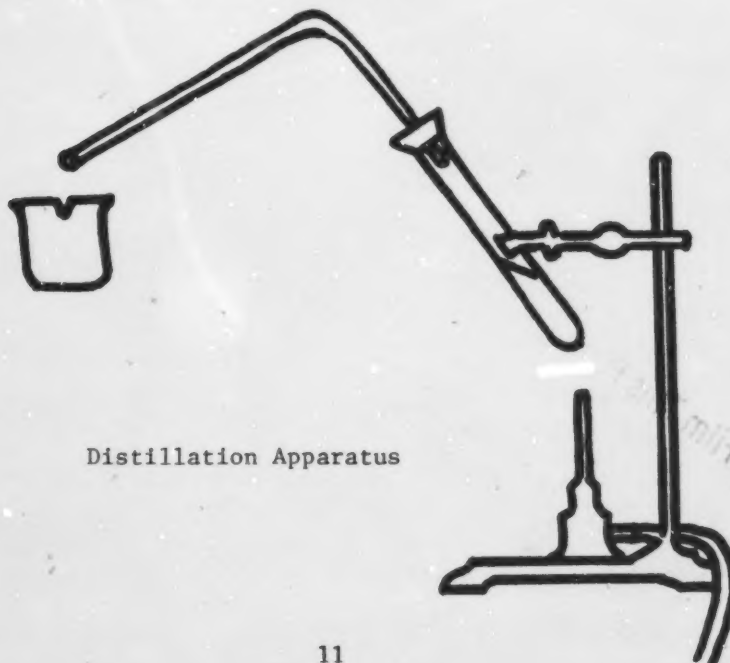
One large 6" test tube-pyrex glass
One hole stopper
8" glass tubing with 90° bend
Ring stand with test tube clamp
Several "contaminated water" samples
Boiling chips (marble chips or glass beads)

STUDENT ACTIVITIES

Set up the distillation apparatus as shown in the diagram. Fill the test tube approximately half full of the contaminated water solution and add a boiling chip to prevent "bumping" when the tube is heated. Heat the tube gently until vapor begins to condense, then adjust the flame to insure a steady stream of vapor. Boil the liquid to approximately $\frac{1}{2}$ of the original volume of the test tube. Remove the flame and let the distillation tube cool.

Remove the distillate and visually compare it with the original contaminated water.

With your teacher's assistance, suggest a scheme of chemical tests to determine what ions are present in the contaminated sample that are no longer present in the distillate.



Distillation Apparatus

III. IDEA A-2

TEACHERS MATERIALS

CONCEPTUAL THEME: III

All living and non-living things are in a constant state of change; nothing is static.

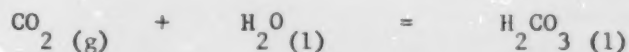
IDEA A:

Natural resources undergo continuous change.

BACKGROUND INFORMATION:

The relationship of pH and dissolved carbon dioxide will give new meaning to that simple test. Even though it is easy to make simple statements about what causes high or low pH values, many substances and conditions are responsible for the final pH. But what is pH? pH is defined as the negative logarithm of the hydrogen ion (hydronium ion) concentration. ($\text{pH} = -\log(\text{H}^+)$) Rather than writing a concentration of $\text{H}^+ = 1 \times 10^{-5} \text{ M}$ (moles/liter), the designation is simple $\text{pH}=5$. As H^+ ion increases in concentration, the negative logarithm decreases numerically. A pH from 1 to 6.9 is designated as acid; a pH of 7 is neutral and a pH of 7.1 to about 14 is called a base.

How does carbon dioxide gas effect the pH? As carbon dioxide dissolves in water we may observe this general reaction:



Actually very little H_2CO_3 is actually present in solution. Instead the reaction could be more correctly stated:



Actually the pH properties concerning carbon dioxide are represented by the concentrations of CO_2 , HCO_3^- , and CO_3^{2-} . The net effect of the addition of CO_2 is to lower the pH. Since carbon dioxide gas concentrations are not high in most natural waters, addition of CO_2 from your breath will change the concentration of dissolved CO_2 and then the pH.

PROCESS OR ACTIVITY:

Measuring, observing, recording, comparing, and inferring.

STUDENT OBJECTIVES:

1. Students will relate pH and the concentration of CO_2 .
2. Students will relate pH to empirical definitions of acid, base, and neutral solution properties.

III. IDEA A-2

STUDENT ACTIVITY

PROBLEM:

Determine the effect of dissolved carbon dioxide on pH.

MATERIALS:

Plastic Drinking Straw
Medicine Dropper
250 ml beaker
Phenolphthalein Indicator
.1M Sodium hydroxide solution

STUDENT ACTIVITY

Fill the 250 ml beaker half full of tap water and add several drops of the phenolphthalein indicator. Add two drops of the .1M sodium hydroxide solution or until a faint pink color persists in the solution. Then add two additional drops to develop and maintain a full color. Take the drinking straw and blow into the solution, making each breath about the same length. Continue with this procedure until the pink color is discharged. Count the number of breaths and keep a record of the breaths and drops of .1M sodium hydroxide used. Repeat this technique several times to see how well your number of breaths correspond to previous trials.

Later collect your data and compare your average values with other students and suggest reasons for similarity and difference.

PROCESS OR ACTIVITIES:

Observing, describing, predicting, and recording.

STUDENT OBJECTIVES:

1. Students will identify the origin of different waters due to their chemical properties.
2. Students will apply the concept of the water cycle to a laboratory situation.

REFERENCES:

Action Chemistry; Laboratory Manual, Bolton, et. al, 1973, pp. 8/6-7.

Chemistry and the Environment, D'Auria, Gilchrist and Johnstone, 1973

III. IDEA A-3

TEACHER MATERIALS

CONCEPTUAL THEME: III

All living and non-living things are in a constant state of change; nothing is static.

IDEA A:

Natural resources undergo continuous change.

BACKGROUND INFORMATION:

The purpose of this experiment is to show the difference in ion content between rainwater and ground water. When water in the form of precipitation falls through the atmosphere it dissolves gases on the way down to the earth's surface. If enough carbon dioxide dissolves in the water it takes on definite properties that distinguish it from water that has been located on the earth's surface for a while. Rainwater is slightly acidic due to the dissolved carbon dioxide. In addition the dissolved carbon dioxide will precipitate with barium chloride solution to form the white solid barium carbonate. A double check to see that this is barium carbonate rather than barium sulfate add 2 or 3 ml of hydrochloric acid and if the solution bubbles, the precipitate is barium carbonate. Ground water or surface waters usually have lost most of their acidic properties and quite often are slightly basic in character. In addition these waters have obtained a salt content due to contact with soils on the way to the body of water. A common ion in many ground waters is chloride. Chloride ion may be precipitated by a solution of silver nitrate. Distilled water if fresh will not contain sufficient concentration of either of these ions to react with barium chloride or silver nitrate reagent.

Preparation for this experiment is simple. You will need three samples of water; distilled water, rainwater and ground water. One liter of each should be sufficient. Distilled water should be fresh and care should be taken not to shake the container allowing carbon dioxide to dissolve in sufficient quantities. If rainwater cannot be obtained use a sample of old distilled water that has been mixed thoroughly with air. Ground water can simply be tap water that is drawn freshly from the faucet. Run a quick check on the tap water, however, since some cities areate their water supplies.

The solution of barium chloride should be .1M, which means dissolving 20.8 grams of the solid in a total solution volume of 1 liter. The silver nitrate solution should also be .1M. It can be prepared by dissolving 17 grams of the solid in a total solution volume of 1 liter.

III. IDEA A-3

STUDENT MATERIALS

PROBLEM:

When water evaporates and recondenses as precipitation, what changes occur?

MATERIALS:

Graduate cylinder
Stirring rod
3 test tubes with labels and marking pen
pH test paper
Water samples to be tested
5 ml. of barium chloride solution
5 ml. of silver nitrate solution

STUDENT ACTIVITIES:

1. Your instructor will have three containers of water labeled A, B, C respectively. Label your three test tubes accordingly and take 10 ml. of each sample. The following chemical tests by you will determine which one of the samples is rain water and which is ground water. The third sample is distilled water and should not respond to any of the chemical tests since the ions that react with the chemical reagents are not present in distilled water.
2. Each of the three solutions; A, B, and C; can be placed in a test tube rack and you should reproduce this data table in your laboratory notebook or on a separate sheet of paper.

Sample	Appearance	Odor	Add BaCl_2	Add AgNO_3	pH	Residue
A						
B						
C						

3. First check the appearance of the three samples. Record your observations. Next smell each test tube and again record your observations.
4. Check pH by using the pH test paper provided by your instructor. Check first with the wide range and then use the appropriate narrow range paper to determine the pH to ± 0.1 . The proper method of acquiring a sample to test pH is by using the stirring rods. Dip the rod into the solution and touch it to the pH paper, never put the paper into the test tube.

5. Now run the evaporation test. Pour a small amount of your liquid into a watch glass and let it evaporate. After this is complete, check your watch glass for any residue. If your time is limited your instructor will show you how to speed the evaporation.
6. The final tests are chemical tests to determine certain ions. The addition of barium chloride solution will precipitate carbonate ion formed from carbon dioxide dissolving in water. Add several drops of the barium chloride test solution and note any clouding or solids being formed and settling to the bottom of the test tube. Record your observations. Next use the silver nitrate solution to perform the final chemical test. Add several drops and make immediate observations to determine clouding or precipitation. Do not wait too long with silver nitrate since it reacts with light to cloud the solution and this reaction might be mistaken for the confirmation of Chloride ion present in solution.
7. Check your watch glass for any residue and then complete your data page. Your instructor will now check your results and explain the reactions. You should be able to determine which solution is the rainwater, the distilled water and the ground water.

Conversely, soils with only large openings retain only a small amount of water and nutrients and are droughty and of low fertility.

PROCESSES OR ACTIVITIES:

Measuring, Comparing, Observing, Computing and Recording

STUDENT OBJECTIVES:

To determine bulk density, particle density, and pore space of given soil samples.

RESOURCES:

Buckman, H.O. and N.C. Brady, The Nature and Properties of Soils, Sixth Edition. New York: The Macmillan Company, 1965.

Millar, C.E., L.M. Turk, and Foth, H.D. Fundamentals of Soil Science, Fourth Edition. New York: John Wiley & Sons, Inc., 1965.

III. IDEA A-4

TEACHER MATERIALS

CONCEPTUAL THEME:

All living and non-living things are in a constant state of change; nothing is static.

IDEA A:

Natural resources undergo continuous change.

BACKGROUND INFORMATION:

Many physical properties within the profile of a mineral soil are closely related to particle size, distribution, or texture. Some of these that determine the suitability for use are: infiltration, percolation, moisture storage, drainage, retention of nutrients, aeration, and root penetration. Texture also influences organic matter content and the relative arrangements of individual particles into groups, called structural aggregates. This exercise measures differences in physical properties between soils of different texture and structure by BULK DENSITY, PARTICLE DENSITY, and POROSITY determinations.

The BULK DENSITY of a soil is the weight of the soil mass per unit bulk volume of dry soil. Since the soil is not all solid but has air (pore) space when dry, the bulk density takes into consideration the total pore space, or volume through which the solid is distributed. Generally, a sandy or coarse textured soil will have a higher bulk density than a clayey or fine textured soil. Pore openings, while large in sandy soils, occupy less of the total volume resulting in clays weighing less than equal volumes of sandy soils. Granulation, or grouping of particles into sand-sized structural aggregates, in some clays increases the number of large-sized openings improving air, water, and root movement while still providing small openings for water and nutrient storage. These conditions are often lacking in sandy soils. A balance between small and large pore openings is better than an excess of either.

PARTICLE DENSITY is the weight of the solid particles in the volume they occupy excluding the pore space. The same mineral particles are often present in both fine and coarse textured soils and the weight of these particles, and the soils, remains virtually constant. Large quantities of light weight organic matter or of heavy iron minerals are the usual reasons for variations found.

PORE SPACE is the term given to the volume of the soil not filled with solid matter. POROSITY is expressed as the percentage of the total volume that is permeated with pores, or not occupied by solid. In moist soils, part of this pore space is filled with water causing a proportionate reduction in the amount of air. Soils with only very fine pore openings drain slowly, are quickly filled with water, and plants die for lack of air.

III. IDEA A

STUDENT MATERIALS

PROBLEM:

To determine bulk density, particle density and pore space of given soil samples.

MATERIALS:

Two 100 ml. clean, dry, graduated cylinders

Two 250 ml. beakers

One small glass tube

Spatula

Stirring rod

Two soil samples

Scales or Balances

BULK DENSITY EQUALS

$\frac{\text{Weight of soil in grams}}{\text{Volume of soil in cc.}}$

(equals ml)

STUDENT ACTIVITY:

1. Copy the following chart.

BULK DENSITY

Soil Type or Number	Weight of Cylinder plus Soil in Grams	Weight of Empty Cylinder in Grams	Weight of Soil in Grams	Volume of Soil in cc. (ml)	Bulk Density in gms/cc

2. Weigh a clean, dry, 100 ml. graduated cylinder, record its weight, and fill it to the 100 ml. mark (equals 100 cc.) with one of the assigned soils. Allow the cylinder to drop freely 5 TIMES through a distance of ONE INCH onto a book or other soft, flat surface. CYLINDERS ARE FRAGILE: DROP WITH CARE!
3. Add soil to fill the cylinder again to the 100 ml. mark and allow it to drop onto a soft, flat surface 3 TIMES through a distance ONE INCH. Again add soil to refill to the 100 ml. mark but do NOT drop.
4. Weigh the cylinder now packed with soil to the 100 ml. mark. Record the weight and make the necessary calculations on the back or on scratch paper.

5. Place a small glass tube upright in the center of a 250 ml. beaker and pour the soil from the graduated cylinder around the tube. Level the surface and set the beaker aside for the porosity determination.
6. Repeat the above procedure with the other assigned soil.

OTHER THINGS TO DO:

1. What physical and chemical conditions of a soil determine its bulk density?
2. How does organic matter affect the bulk density of soils?
3. Which, in general, has the higher bulk density: a sandy soil or a clayey soil? Explain why.

III. IDEA A-5

TEACHER MATERIALS

CONCEPTUAL THEME: III

All living and non-living things are in a constant state of change;
nothing is static.

IDEA A:

Natural resources undergo continuous change.

PROCESS OR ACTIVITY:

Measuring, Observing, Recording, Comparing and Inferring

STUDENT OBJECTIVES:

1. Students will relate the chemical parameter pH to conditions for plant growth.
2. Students will determine humus content in soil.
3. Students will identify nitrogen through a chemical change.

III. IDEA A-5

STUDENT ACTIVITIES

PROBLEM:

Identify some properties of soil.

MATERIALS:

Red litmus paper
Deionized water
Universal pH paper; narrow and wide range kit
Peat Moss sample
.01M NaOH-Sodium Hydroxide
.01M HCl -Hydrochloric Acid
Test Tube-25mm x 200mm (pyrex glass)
Filter Paper
Funnel

BACKGROUND:

Three chemical properties of soil may be investigated with very simple equipment. The chemical parameters of pH, Humus Content and Nitrogen content can be determined in the following manner:

EXPERIMENTAL PROCEDURE:

pH: Weigh out 1 gram to centigram precision of your Peat Moss sample and place it in the 25 x 200 mm test tube. Next add 10.0 ml of deionized water and cork the test tube. Shake vigorously for about one minute, then filter the mixture. Save the soil extract and supernatant liquid layer. Test the liquid layer with wide range pH paper and then follow with appropriate narrow range pH paper to determine pH to $\pm .1$ pH. Make a statement concerning your soil's pH character using the following generalized table. Record all pertinent data on the data sheet provided for this experiment.

SOIL FACTS - TABLE 1

pH range ideal for plant growth	6.0-7.5
basic soils	7.1-11.0
acidic soils	4.0-6.9
<u>Crops vs pH range</u>	
wheat	6.0-7.0
green peas	6.0-7.5
oranges	6.0
cranberries (can grow well)	4.0
<u>land qualities vs pH</u>	
wet humid regions	5.0 to 6.8
dry arid regions	9.5 to 11.0

HUMUS IN SOIL:

Weigh out approximately 25.0 grams of soil to centigram precision and place the sample in an evaporating dish. Your teacher will demonstrate the technique "weight by difference". Remove the moisture by heating the sample for 4 hours in a drying oven at 110°C. Reweigh the sample again to the nearest centigram. Attribute the loss in mass primarily to the water content of the soil. Transfer a sample of the dry soil to a pre-weighed crucible and reweigh to centigram precision. Remove the lid from the crucible and heat vigorously for 15 minutes. It would be best to heat the mixture with the crucible cover removed in a chemical hood or well ventilated area. The resultant mixture after heating should be free of organics or humus. Finally weigh the crucible, cover and contents. Record all information on the data sheet provided for this experiment. Your teacher will instruct you on each calculation to give you correct % of water vapor and % humus content.

NITROGEN IN SOIL:

The test for nitrogen is a qualitative test rather than a quantitative test; meaning it simply indicates if nitrogen is present in the soil sample. Obtain a sample of soil in the 25 x 200 mm glass (pyrex) test tube. Fill the test tube approximately $\frac{1}{2}$ full. Next obtain a piece of red litmus papers and moisten it with deionized water. Support the litmus paper with a match stick or piece of metal wire and hang it at the top of the test tube as indicated in the drawing shown below. Heat the sample vigorously for 5 to 10 minutes and note the change in the sample and color of the litmus paper. Record your observations on the data sheet.

DATA SHEET #1

SOIL PROPERTIESpH

pH of deionized water _____

pH of soil extract _____

- wide range indicator

- narrow range indicator

Description of Soil

Characteristics:

Humus in Soil

Weight of evaporating dish and soil _____ before heating

Weight of evaporating dish and soil _____ after heating

Weight of evaporating dish _____

Weight of soil _____ before heating

Weight of soil _____ after heating

Weight of crucible and soil sample _____ before combustion

Weight of crucible and soil sample _____ after combustion

Weight of crucible _____

Weight of soil sample _____ before combustion

Weight of soil sample _____ after combustion

% moisture in soil sample _____

% humus in soil sample _____

Nitrogen in Soil

Color of litmus before nitrogen test:

Color of litmus before nitrogen test:

Appearance of soil sample before heating:

Appearance of soil sample after heating:

III. IDEA A-6

TEACHER MATERIALS

CONCEPTUAL THEME:

All living and non-living things are in a constant state of change; nothing is static.

IDEA A:

Natural resources undergo continuous change.

BACKGROUND INFORMATION:

Each soil textural class has particular characteristics that depend upon the relative amount of the different separates it contains. With experience you can gain the skill to make an approximate estimate of a soil textural class based largely on its "feel" to the fingers under dry, moist, and wet conditions. Properties of the separates are more accurately determined when the soil is moist than when dry. The size range and general feel of the separates when MOIST are listed below:

VERY COARSE SAND	2.0	to	1.0	mm	Very gritty
COARSE SAND	1.0	to	0.5	mm	" "
MEDIUM SAND	0.5	to	0.25	mm	" "
FINE SAND	0.25	to	0.10	mm	Gritty
VERY FINE SAND	0.10	to	0.05	mm	Slightly gritty
SILT	0.05	to	0.002	mm	Smooth, velvety, buttery
CLAY	smaller than		0.002	mm	Sticky and plastic

PROCESSES OR ACTIVITIES:

Measuring, Comparing, Observing, Classifying, and Recording

STUDENT OBJECTIVES:

1. To determine what is soil texture.
2. To determine soil texture by feel.
3. To record findings from a scientific investigation.

RESOURCES:

Buckman, H.O. and N.C. Brady, The Nature and Properties of Soils. Sixth Edition. New York: The Macmillan Company, 1965.

Miller, C.E., L.M. Turk, and Foth, H.D., Fundamentals of Soil Science. Fourth Edition. New York: John Wiley & Sons, Inc. 1965.

The United States Department of Agriculture, Soil, The Yearbook of Agriculture. Washington, D.C. 1957.

Soil Improvement Committee, California. Western Fertilizer Handbook. Fertilizer Association, Ochsner Bldg., Room 213, Sacramento, 14, California.

III. IDEA A-6

STUDENT MATERIALS

PROBLEM:

Determining soil texture by feel.

MATERIALS:

Known samples of soil for comparison
Soft drink bottles of water, with rubber stoppers with holes
Paper towels
Various soil samples, preferably from student's home area

STUDENT ACTIVITIES:

1. Examine the dry soil for clods and the ease of breaking them by pressing between the fingers. Soils high in sand are seldom cloddy. Soils high in silt may be cloddy, but usually break suddenly to a soft powder showing a fingerprint. Soils high in clay are usually cloddy and dry granules are often hard to break even with pressure.
2. Take about a half-tablespoon of soil. Moisten it gradually with small amounts of water, kneading it vigorously until all dry lumps are wet. (If too much water has been used, increase the volume of soil.) When all of the soil is moist (it will have a stiff consistency if much clay is present), test the ease of forming a ball. then try to squeeze the soil into a ribbon by working it between the thumb and forefinger. Soils high in sand feel gritty and ribbon poorly, unless they are also high in clay. Soils high in silt feel smooth, velvety, or buttery and usually show a fingerprint clearly. Soils may form a short ribbon, its length varying with the clay content. Soils high in clay can often be pressed out into very thin ribbons two or more inches long. (Dark soils high in organic matter feel more silty than analysis shows them to be since humus feels more like silt than clay).
3. Increase the moisture to saturation, note the amount of staining of the fingers, and try to judge the amount of grittiness of sand in relation to the smoothness of silt and stickiness of clay. You may want to wash out (carefully) the clay and silt to determine the amount of sand present. Remember, a few grains of very coarse sand equal many fine grains. Sand gives a grinding sound when held close to the ear and very fine sand is distinguished from silt in this manner. Grittiness denotes a sandy soil and it can be detected both by feel and sound. Clay or loam is indicated if the moist soil ball stains your fingers. Clay is sticky. Silt is smooth and velvety. Clay soil will "ribbon". Silt loam will form a firm ball.

RESULTS: List findings below.

A. Known Samples

No.	Soil Textural Class	Primary and secondary characteristics
1		
2		
3		
4		
5		
6		

B. Unknown Samples

No.	Soil Textural Class	Primary and secondary characteristics
1		
2		
3		
4		
5		
6		

OTHER THINGS TO DO:

List the soil properties that are related to soil color.

Feels and sounds gritty. Ball usually breaks in your hand.

Almost no ribbon.



COARSE



Usually smooth. Ball shows some finger marks and holds its shape.

Has short thick ribbon.



MEDIUM



Feels smooth and sticky. Ball shows finger marks. Holds shape.

Long thin ribbon.



FINE



III. IDEA A-7

TEACHER MATERIALS

CONCEPTUAL THEME:

All living and non-living things are in a constant state of change, nothing is static.

IDEA A:

Natural resources undergo continuous change.

BACKGROUND INFORMATION:

The solid portion of ordinary agricultural soils consists of organic matter and of minerals. The mineral portion is classified into groups having definite size limits. Each subdivision on size is called a soil separate and five of these separates are generally recognized, namely: fine gravel, coarse sand, fine sand, silt, and clay.

The proportionate amounts of the various separates that constitute any given soil govern the texture of that soil and determines to a large extent the physical and chemical characteristics of the soil. A coarse textured soil means that the large particles predominate, while in a fine textured soil the silt and clay separates are dominate.

In order that the mineral particles or separates may be studied successfully they must be separated into convenient groups. The separation of particles of soil into groups, each group comprising particles whose sizes fall within certain definite limits, is called a mechanical analysis.

PROCESSES OR ACTIVITIES:

Measuring, Observing, Classifying, Computing and Recording

STUDENT OBJECTIVES:

1. Measure and mix given materials properly.
2. Measure depth of sand and silt layer.
3. Compute the depth of the clay layer.
4. Convert the measurements into percentage figures.
5. Record findings.

RESOURCES:

The Nature and Properties of Soils, Buckman, H.O. and N.C. Brady, Sixth Edition. New York: The Macmillan Company, 1965.

Fundamentals of Soil Science. Millar, C.E., L.M. Turk, and Foth, H.D. Fourth Edition. New York: John Wiley and Sons, Inc. 1965

III IDEA A -7

STUDENT MATERIALS

PROBLEM:

What are the mineral or inorganic parts of soil?

MATERIALS:

Various soil samples
1 fruit jar and lid for each sample
8% Calgon solution - Mix 6 tablespoons of Calgon per qt. of water
Ruler - graduated in the metric system
Measuring cup
Tablespoon

STUDENT ACTIVITIES:

1. Place approximately one-half cup of soil in a quart jar. Add five tablespoons of the 8% Calgon and three and one half cups of water. Cap and shake for five minutes. Place the jar on the desk and let stand for 24 hours.
2. At the end of 24 hours, measure the depth of settled soil. This represents the total depth of soil. Shake thoroughly for five minutes. Place the jar on the desk and let stand for 40 seconds. Now measure the depth of settled soil with a ruler. This is the sand layer.
3. At the end of 30 minutes measure the depth of settled soil and subtract the depth of sand from this depth to get the depth of the silt layer.
4. The remaining unsettled part represents the clay fraction.
5. Record your results for each of the soil samples.

The measurements may be converted into percentage figures according to the following example:

a. Total depth of soil	23mm
b. Depth of Sand Layer	9mm
c. Depth of Silt Layer	10mm

$$\% \text{ Sand equals } \frac{9\text{mm}}{23\text{mm}} \times 100\% = 39\%$$

$$\% \text{ Silt equals } \frac{10\text{mm}}{23\text{mm}} \times 100\% = 43.5\%$$

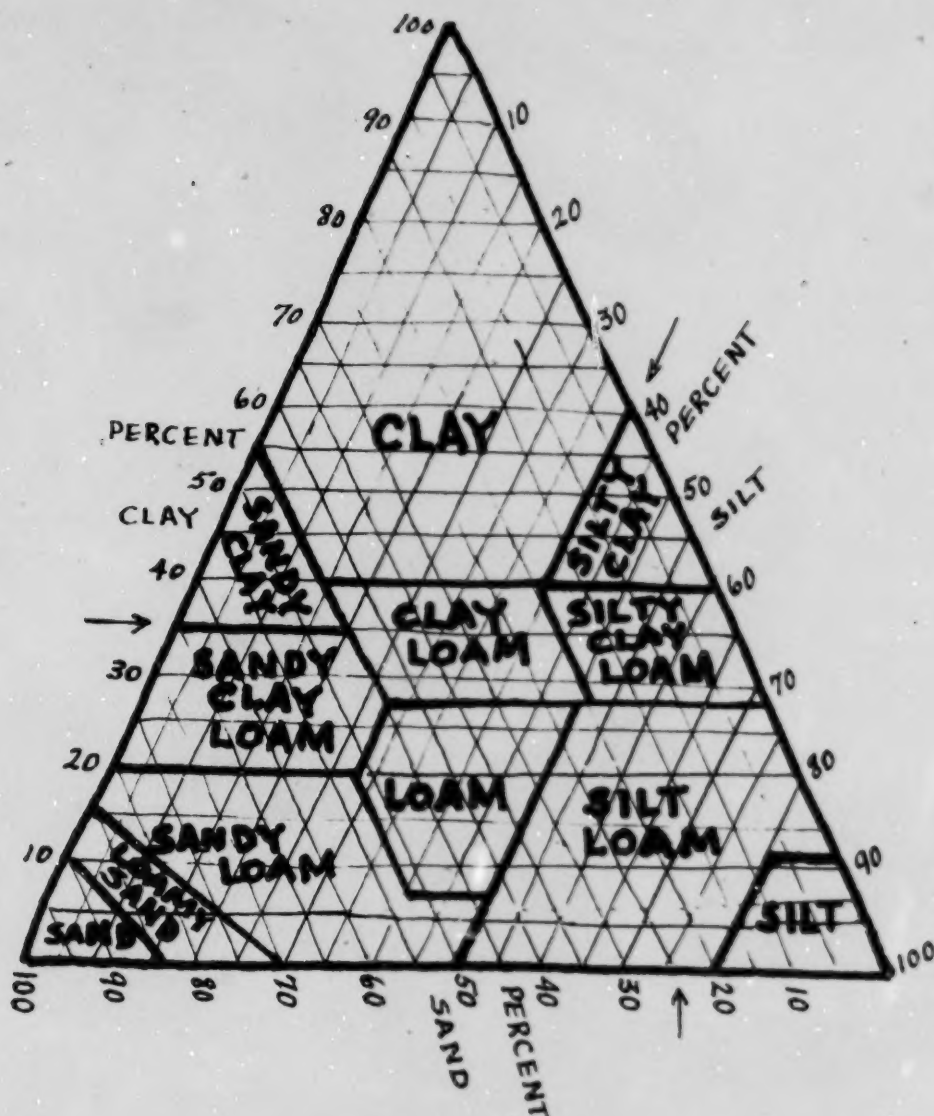
$$\% \text{ Clay equals } 100\% - (39\% \text{ plus } 43.5\%) = 17.5\%$$

OTHER THINGS TO DO:

Determine the textural class of each soil

Note: (Use the soil textural classification triangle.)

SOIL TEXTURAL CLASSIFICATION



HOW TO USE THE TEXTURAL CLASSIFICATION TRIANGLE

Locate the percent stand along the bottom of the triangle. Follow from this point UP AND TO THE LEFT, parallel with the right side of the triangle. The percent sand is constant anywhere along this line. Locate the percent clay along the left side of the triangle and follow from this point HORIZONTALLY ACROSS to the right. The textural class for the soil is shown in the area where the sand and clay percentages cross. Check the accuracy of this point by locating the percent silt along the right side of the triangle and follow DOWN AND TO THE LEFT. The percent silt should meet the intersection of the sand and clay percentages.

III. IDEA A -8

TEACHER MATERIALS

PROBLEM:

To determine bulk density, particle density and pore space of given soil samples.

STUDENT ACTIVITIES:

Activity III

1. Copy the following chart.

PARTICLE DENSITY

Soil Type or Number	Weight of Soil in Grams	Volume of Water and Soil in cc. (ml.)	Total Volume of Water Added in cc. (ml.)	Portion of Volume Occupied by Soil in cc.	Particle Density in Grams/cc.

2. Place 50 ml. of tap water in a 100 ml. graduated cylinder. Weigh carefully a 50 gram sample of dry soil and pour it into the water.
3. Cover the mouth of the graduated cylinder with the palm of the hand and gently rock it back and forth to mix the soil and water thoroughly. Rinse the sides of the cylinder with a measured amount of water (10 ml. is usually enough). Let the mixture stand for 5 minutes and determine the new water level height.
4. Record results and make the necessary calculations.
5. Repeat the above procedure with the other soil.

III. IDEA A-8

STUDENT MATERIALS

PROBLEM:

To determine bulk density, particle density and pore space of given soil samples.

STUDENT ACTIVITIES:

Activity II.

1. Copy the following chart

PORE SPACE

Soil Type Number	Volume of Water added to Pore Space - cc	Volume of soil in cc. (ml.)	Per cent Pore	Per Cent Pore Space by Calculations: % equals $100 - \frac{(\text{Bulk Density} \times 100)}{\text{Particle Density}}$

2. Fill a 100 ml. graduated cylinder to the 100 ml. mark with tap water. Pour the water SLOWLY onto the soil in the beaker with the glass rod. Stop adding water when it stands at the same level as the soil surface. Do NOT stir the soil or shake the beaker.
3. Determine the amount of water used to exactly fill the pore space in the 100 cc. (ml.) volume of soil by subtracting the reading on the side of the graduated cylinder from the original volume.
4. Record your results and make the necessary calculations on the chart above.
5. Repeat the above procedure with the other soil.

OTHER THINGS TO DO:

1. What effect does pore size have on the rate of water movement through the soil?
2. How does total pore space vary with texture? With volume weight?
3. About what proportion of the pore space should be occupied by air when the soil is in optimum condition for plant growth? Explain why.

TEACHER MATERIALS

CONCEPTUAL THEME: III

All living and non-living things are in a constant state of change; nothing is static.

IDEA C

Man made environmental changes may change or destroy beneficial natural environments.

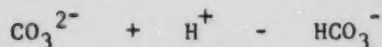
BACKGROUND INFORMATION:

The capacity of natural waters to neutralized acid is known as ALKALINITY. Alkalinity is an important water quality parameter and is not a simple relationship, due to the natural buffer action of the three main ions comprising the property of alkalinity. These ions are bicarbonate (HCO_3^-) carbonate (CO_3^{2-}) and hydroxide (OH^-). The theory of buffers is best explained in an advanced chemistry class; if this is the case an excellent article concerning buffers may be found in CHEMISTRY magazine or any college chemistry text. If you do not wish to go into detail a suitable description of the general reactions follow:

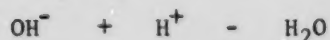
The primary species contributing to alkalinity are bicarbonate ion,



carbonate ion,



and hydroxide ion.



Other minor contributions to alkalinity are ammonia and the conjugate bases of phosphoric, silicic, boric and organic acids.

Alkalinity generally is expressed as "phenolphthalein alkalinity" corresponding to the titration end point at pH = 8.3. This is the pH ($= -\log_{10}(\text{H}_3\text{O}^+)$) at which bicarbonate (HCO_3^-) is the predominant carbonate species. The term "total alkalinity" corresponds to the titration end point at pH = 4.3 utilizing the indicator methyl orange. At pH = 4.3 both the bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) have been converted to carbon dioxide. The use of these end points can help determine amount of chemicals to use for treating raw water for domestic uses. For example, water that is to be used in a municipal water system should not have a low pH. If too many acidic properties are found in municipal water; the city maintenance crew will spend much of their time replacing water pipes which have actually been dissolved by the acid in water.

pH and alkalinity are obviously related. To qualitatively describe them. pH can be described as an intensity factor while alkalinity can be described as a capacity factor; that is the capacity of water to neutralize added acid.

An illustration of the intensity property (pH) in contrast to the capacity property (alkalinity) can be found in the following table:

<u>SOLUTION</u>	<u>pH (intensity)</u>	<u>Alkalinity (capacity)</u> expressed in milliequivalents of strong acid
.001 M NaOH	11.00	.001 meq
.100 M NH ₃ (aq)	11.13	.100 meq

Notice that both solutions have about the same pH which indicates approximately the same intensity; however, notice that the NH₃(aq) solution has 100 times the alkalinity of the NaOH solution.

SOLUTION PREPARATION

Listed below are the instructions for making the solutions necessary for this laboratory.

.02 N H₂SO₄- SULFURIC ACID- First prepare a 6N (3M) solution of the acid.

For this solution dissolve 168 ml of concentrated sulfuric acid to make 1 Liter of solution. Use 3.4 ml of the 6N sulfuric acid solution and dilute to a total volume of one liter for .02N.

Methyl Orange Indicator-Dissolve 1 gram of Methyl Orange in 1 liter of water.

Phenolphthalein Indicator-Dissolve 1 gram of phenolphthalein in 50 ml of alcohol and 50 ml of water.

A full interpretation of this laboratory can include a more intensive analysis of data obtained in the experiment. The following page may be used as a student page. It will be a more thorough development of this experiment.

Calculations:

From your plot obtain the volumes of the first end point and the second end point corresponding to the end point of phenolphthalein and the end point of methyl orange.

Use the following formulas to calculate P and T; then using the table provided on the first page of this experiment calculate in PPM the concentration of each radical present.

Phenolphthalein alkalinity as mg/l (PPM) CaCO_3

$$\frac{X_1 \times N \times 5 \times 10^4}{\text{ml sample}} = P \text{ (phenolphthalein end point)}$$

Total alkalinity as mg/l CaCO_3

$$\frac{X_2 \times N \times 5 \times 10^4}{\text{ml sample}} = T \text{ (methyl orange end point)}$$

X_1 = phenolphthalein end point X_2 = methyl orange end point

N = normality of the acid (.02N)

Unknown:

Obtain a fresh lake water sample and repeat the above process. Compare your result with other data collected. Make sure you mention the lake and the significance of the difference in any values obtained from the lake water and tap water samples.

PROCESS OR ACTIVITIES:

Observing, measuring, recording, calculating, graphing, and interpreting data.

STUDENT OBJECTIVES:

1. Students will relate the concept of alkalinity through a laboratory exercise to a chemical measurement, pH.
2. Students will demonstrate the laboratory technique of titration.
3. Students will define alkalinity in terms of chemical experimentation.
4. Students will define pH in terms of chemical experimentation and the mathematical definition of this term.

REFERENCES:

Morris, Daniel Luzon, Chemistry, 44, pp. 15-19 (1971)

American Public Health Association, "Standard Methods for the Examination of Water and Wastewater", American Public Health Association, Inc., New York, N. Y., 1965, pp. 195-198.

III. IDEA C-1

STUDENT MATERIALS

PROBLEM:

Determine the capacity of natural water to neutralize acid.

MATERIALS:

.02N Sulfuric Acid (H_2SO_4)
Methyl orange indicator
Phenolphthalein indicator
buret
buret holder
2 erlenmeyer flasks
wash bottle
1 pH paper kit (to include wide/narrow range paper)
1 50 ml graduate cylinder

STUDENT ACTIVITIES:

BACKGROUND:

The measurement of alkalinity is important for the classification of water. Alkalinity is the capacity of a water to accept protons. Although it would appear that alkalinity would be directly proportional to the pH, this is not inevitably true. The reason for this seeming paradox is that the alkalinity in most naturally occurring water is composed of OH^- , CO_3^{2-} , and HCO_3^- (hydroxide, carbonate and bicarbonate radicals) in conjunction with several cations which form an excellent buffering system.

In many laboratories colored indicators are still used to determine total alkalinity. The two chosen are phenolphthalein and methyl orange, having end points of 8.3 and 4.5 respectively. For that reason you will find alkalinity described as phenolphthalein or methyl orange alkalinity. The two pHs are significant since they describe the nature of the alkalinity; ie:

Alkalinity Relationships

Result of Titration	<u>Hydroxide</u> <u>alkalinity</u> <u>as CaCO_3</u>	<u>Carbonate</u> <u>alkalinity</u> <u>as CaCO_3</u>	<u>Bicarbonate</u> <u>alkalinity</u> <u>as CaCO_3</u>
P=O	0	0	T
$P < \frac{1}{2}T$	0	2P	T-2P
$P = \frac{1}{2}T$	0	2P	0
$P > \frac{1}{2}T$	2P-T	2(T-P)	0
P=T	T	0	0

Where P=phenolphthalein alkalinity T=total alkalinity

Carbonate is present when the phenolphthalein alkalinity is not zero but less than the total alkalinity.

Hydroxide is present if the phenolphthalein alkalinity is more than half the total alkalinity.

Bicarbonate is present if the phenolphthalein alkalinity is less than half the total alkalinity.

It should be noted that alkalinity, as well as many other commonly found constituents of water are reported by water chemists as ppm CaCO_3 (mg/l CaCO_3). By using this convention it is possible for the information to be easily manipulated.

PROCEDURE

This experiment will take three laboratory partners working together. First make a liter of a .02N H_2SO_4 (.01 M H_2SO_4) showing your completed calculations for approval.

Clean three 250 ml erlenmeyer flasks and rinse with deionized water. Measure out and place 100 ml of tap water in each flask using a graduate cylinder. Check pH of the tap water and record your information on a data sheet similar to the one below:

	pH	ml
example	8.5	0.0

Add two drops of phenolphthalein to each flask. If the pH is above 8.3 a faint pink color will persist. Next cut 10 tiny squares of the wide range pH paper for use during the titration. Record your data and begin titrating the solution with the .02N H_2SO_4 previously prepared. Check the pH every ml until you get near an end point; then check the pH every .1 ml. The pink color should disappear at 8.3; mark this point with an (*) on your data sheet. Now add two drops of the methyl orange indicator and continue the titration. Repeat the procedure taking note of the pH every ml until your next end point is near; then check pH every .1 ml. The pH at the methyl orange's end point should be from orange to yellow. Perform this titration as fast as possible and with minimum stirring to avoid considerable dissolution of atmospheric CO_2 in your sample.

ORGANIZE your lab team to have:

1. One person titrating with the buret
2. One person checking pH
3. One person taking data for the group

To get good results, the process should be repeated for three different trials with each individual getting his chance at each job. The average values can then be obtained from the data. A good set of values will be within .1 to .2 ml apart.

Make a graph plotting pH vs. ml of titrant used.

TEACHER MATERIALS

CONCEPTUAL THEME:

All living and non-living things are in a constant state of change; nothing is static.

IDEA C:

The earth's surface is in a continuous state of change.

BACKGROUND INFORMATION:

The inorganic solid part of soils is derived from rocks and their minerals. The student should therefore be familiar with the most abundant and generally common rocks and minerals. Most of the common rocks and soil-forming minerals can be identified without the use of a microscope. The list included in this exercise has been kept as brief as possible but is designed to include all of the easily recognizable minerals and rocks which enter into the mineralogical composition of soils. The many different types of rocks and minerals have led to the formation of numerous types of soils.

PROCESSES OR ACTIVITIES:

Observing, Identifying, Recording

STUDENT OBJECTIVES:

Identify and record from a set of known mineral samples and prepare a chart identifying each one as to streak color hardness, physical appearance, nutrient elements, and name.

RESOURCES:

Buckman, H.O. and N.C. Brady. The Nature and Properties of Soils
Longwell, C.R., A. Knopf, and R.F. Flint. Physical Geology
Loomis, Frederic B. Field Book of Common Rocks and Minerals.
Millar, C.E., L.M. Turk, and H.D. Foth. Fundamentals of Soil Science.
Pough, Frederic K. Field Guide to Rocks and Minerals.

III. IDEA C-2

STUDENT MATERIALS

PROBLEMS: What are some of the common soil-forming minerals?

MATERIALS:

Set of known mineral samples
Various unidentified samples - numbered
Unglazed porcelain plate
Copper penny
Steel knife
6" x 6" window glass - or old microscope slides
File

STUDENT ACTIVITIES:

Using the information below along with that you gain by your observing and testing, fill in the chart given in this exercise.

PRIMARY MINERALS

1. Quartz _____ SiO_2
2. Feldspars
 - a. Orthoclase _____ KAlSi_3O_8
 - b. Plagioclase _____ $(\text{Na,Ca}) \text{AlSi}_3\text{O}_8$
3. Micas
 - a. Muscovite _____ $\text{H}_2\text{KAl}_3 (\text{SiO}_4)_3$
 - b. Biotite _____ $\text{H}_2\text{K} (\text{Mg,Fe})_3 \text{Al} (\text{SiO}_4)_3$
4. Ferro-Mags
 - a. Hornblende (Amphibole) _____ $\text{CaMg}_2 (\text{Al,Fe})_2 \text{Si}_3\text{O}_{12}$
 - b. Augite (Pyroxene) _____ $\text{CaMg} (\text{Al,Fe}) (\text{SiO}_3)_2$
5. Apatite _____ $\text{Ca}_4 (\text{PO}_4)_3 \cdot \text{Ca} (\text{Cl,F})$
6. Tourmaline _____ $\text{NaMg}_3\text{B}_3\text{Al}_3 (\text{Al}_3\text{Si}_6\text{O}_{27}) (\text{OH})_4$
7. Pyrite _____ FeS_2

III. IDEA C-2

STUDENT MATERIALS

RESULTS:

1. Which of those in the chart would be most resistant to forces of wind, water, and temperature?
2. What effect would the hardness of the parent material have on the soil which is formed?
3. What effect would the color of the parent material have on the soil which is formed?
4. Why are minerals important in the field of agriculture?
5. What plant nutrients elements come from minerals?
6. What soil minerals are the source of the following nutrient elements?
 - a. P
 - b. K
 - c. Ca
 - d. Mg
 - e. S
 - f. Fe
7. Which of the above elements has the least number of mineral sources?
8. Why are soils that are high in quartz usually low in plant nutrients?

OTHER THINGS TO DO:

1. Test other minerals for identification.
2. Which of these minerals might yield a sandy soil? A clay soil?

III. IDEA C-2

STUDENT MATERIALS

Hardness number	Mineral example	Description
Soft {	1 Talc	Has a greasy feel to the fingers
	2 Gypsum	Easily scratched by the finger-nail
Medium {	3 Calcite	Scratches finger nail
	4 Fluorite	Scratched rather easily by a knife; scratches copper coin
	5 Apatite	Rarely scratched by a knife
Hard {	6 Orthoclase	Scratched by a file; scratches glass
	7 Quartz	Barely scratched by file; scratches glass readily.
Very Hard {	8 Topaz	
	9 Corundum	Do not yield essential nutrients
	10 Diamond	

III. IDEA C-2

STUDENT MATERIALS

SECONDARY MINERALS

1. Iron Oxides
 - a. Hematite Fe_2O_3
 - b. Limonite $2\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$
 - c. Magnetite Fe_3O_4
2. Gypsum $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
3. Dolomite $\text{CaMg}(\text{CO}_3)_2$
4. Serpentine $\text{H}_4\text{Mg}_3\text{Si}_2\text{O}_9$
5. Kaolinite $\text{H}_4\text{Al}_2\text{Si}_2\text{O}_9$
6. Halite NaCl
7. Calcite CaCO_3
8. Talc $\text{H}_2\text{Mg}_3\text{Si}_4\text{O}_{12}$
9. Sphalerite ZnS
10. Chalcopyrite CuFeS_2

III. IDEA C-2

STUDENT MATERIALS

MINERALS

Group	Name of Mineral	Color of Streak	Hardness	Physical Appearance	Nutrient Elements Contained	Unknown Sample
Oxides	Quartz					
	Hematite					
	Magnetite					
	Limonite					
Sulfide	Sphalerite					
	Chalcopyrite					
	Pyrite					
Carbonates	Calcite					
	Dolomite					
Feldspars	Orthoclase					
	Plagioclase					
Micas	Muscovite					
	Biotite					
Ferro-Mags	Amphibole					
	Pyroxene					
Chloride	Halite					
Sulfate	Gypsum					
Phosphate	Apatite					
Hydrous Silicates	Kaolinite					
	Talc					
	Serpentine					
Silicate	Tourmaline					

- a. gneiss - (a foliated granitoid rock of igneous origin)
- b. schist - (thinly laminated rock of felsitic igneous origin)
- c. slate - (a fine grained rock tending to split into thin leaves)
- d. quartzite - (recrystallized quartz grains)
- e. marble - (metamorphosed limestone or dolomite)

PROCESSES OR ACTIVITIES:

Observing, Identifying and Recording

STUDENT OBJECTIVES:

Identify and record from a set of known rocks the following data:

Class (Igneous, Sedimentary or Metamorphic)

Texture (Coarse or Fine)

Name principle minerals

Physical Appearance (color)

Hardness to Knife

RESOURCES:

Buckman, H.O. and N.C. Brady. The Nature and Properties of Soils.

Longwell, C.R., A. Knopf, and R.F. Flint. Physical Geology.

Loomis, Frederic B. Field Book of Common Rocks and Minerals.

Millar, C.E., L.M. Turk, and H.D. Foth. Fundamentals of Soil Science.

Pough, Frederic K. Field Guide to Rocks and Minerals.

III. IDEA C-3

TEACHER MATERIALS

CONCEPTUAL THEME:

All living and non-living things are in a constant state of change; nothing is static.

IDEA C:

The earth's surface is in a continuous state of change.

BACKGROUND INFORMATION:

A rock may be defined as any mineral or aggregate of minerals that forms an essential part of the earth. Rocks are fundamentally classified on the basis of their origin. Thus three large divisions have been established as follows:

1. Igneous Rocks which have been brought up from below in a molten condition and which owe their present structural peculiarity to variation in conditions of solidification and composition are igneous. Igneous rock has a homogeneous appearance; that is, one surface is like any other surface. There is no evidence of any stratified, banded or foliated structure, such as are easily distinguished in sedimentary or metamorphic rocks.

These are the primary rocks from which all other rocks have been directly or indirectly derived. They are accordingly treated first. Those important representatives of the various groups of igneous rocks, classified on the basis of their texture and composition, should be understood and studied for future identification of unlabelled specimens. Some of the more important members of this group are:

- | | |
|------------|-------------------------|
| a. granite | e. diorite |
| b. basalt | f. tuff, scoria, pumice |
| c. gabbro | g. obsidian |
| d. syenite | |

2. Sedimentary. The sedimentary rocks may be formed from particles of igneous, metamorphic, or other sedimentary rocks, by disintegration or solution, by transportation with wind, water or ice, and by sedimentation or precipitation. The particles are usually cemented together by CaCO_3 , silica, or iron oxide. Some of the more important members of this group are:

- | | |
|-----------------|--|
| a. conglomerate | d. limestone (CaCO_3) |
| b. sandstone | e. dolomite ($\text{CaMg}(\text{CO}_3)_2$) |
| c. shale | |

3. Metamorphic. These are the secondary rocks which may rise from either igneous or sedimentary rocks as a result of pressure, heat, or chemical action, either alone or in combination. Some of the more important are:

III. IDEA C-3

STUDENT MATERIALS

PROBLEMS:

What are some of the soil-forming rocks?

MATERIALS:

Known rock samples
Steel knife

STUDENT ACTIVITIES:

Using the information below and that you gain by your observation and testing, fill in the chart given in this exercise. Note its physical appearance, texture and hardness.

Scratch each sample with a knife. If the rock is easily scratched, it is soft; lightly marked, medium; and not affected by the knife, hard.

RESULTS:

1. What agencies break down rocks and minerals?
2. Why is sea water "salty"?
3. What is the difference between calcic and dolomitic limestone?
4. List several rocks which are rather resistant to weathering.
5. List several rocks which decompose readily.

OTHER THINGS TO DO.

1. Which of these rocks are responsible for a great part of the soil in Florida?

III. IDEA C-3

STUDENT MATERIALS

ROCKS

Name of Rock	Class Igneous Sedimentary Metamorphic	Texture Coarse or Fine	Name Principle Minerals	Physical Appearance (Color)	Hardness to Knife
Conglomerate					
Basalt					
Gneiss					
Granite					
Coral					
Limestone					
Marble					
Obsidian					
Pumice					
Quartzite					
Sandstone					
Schist					
Scoria					
Shale					
Travertine					

III. IDEA C-4

TEACHER MATERIALS

CONCEPTUAL THEME:

All living and non-living things are in a constant state of change; nothing is static.

IDEA C:

The earth's surface is in a continuous state of change.

BACKGROUND INFORMATION:

Rainfall and the water holding capacity of soils have been economically important to man from the beginning. Soil moisture has always been of vital importance to plant life. Almost every phase of soil research involves moisture determinations, or each soil that is analyzed, in order that the results of the analysis may be applied to the soil as it exists in the field, in the greenhouse, or in the laboratory.

In nature we find three conditions or forms of soil moisture: (1) hygroscopic, (2) capillary, and (3) gravitational. Hygroscopic moisture is that thin film of moisture in the soil which surrounds the soil particles, and which is absorbed from the air and condensed on the surface of the particles when there is no other source of supply at hand. If the film becomes thicker because of another supply, as rainfall or underground water, the additional water is termed capillary moisture. Hygroscopic water is always stationary, while capillary water is able to move about. With the advent of more moisture the film becomes so thick that the absorbing force is not sufficient to hold all of the water and any excess flows downward through the pore spaces due to the force of gravity. This excessive form of water is the gravitational water.

PROCESSES OR ACTIVITIES:

Collecting, Measuring, Identifying, Observing and Recording

STUDENT OBJECTIVES:

To determine the total moisture content of a sandy soil and a loamy soil and the different types of soil moisture.

RESOURCES:

- Buckman, H.O. and N.C. Brady. The Nature and Properties of Soils. Sixth Edition, New York: The Macmillan Company, 1965.
Donahue, R.L. Soils: An Introduction to Soils and Plant Growth. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1958.
Millar, C.E., L. M. Turk, and H.S. Foth. Fundamentals of Soil Science. Fourth Edition, New York: John Wiley and sons, Inc., 1965.

III. IDEA C-4
Activity (1)

STUDENT MATERIALS

PROBLEM:

Is moisture found in the soil?

MATERIALS:

A sandy soil

A loamy soil (Both soils should be air-dry and crumbled to about 2.0 mm.)

Two one-gallon cans with holes punched in the bottom, or lamp chimneys.

Two pieces of window screen placed in the bottom of each can.

Two measuring jars to hold water.

Two beakers to hold the water that passes through the soils.

Two stands for the gallon cans.

STUDENT ACTIVITIES: (Activity 1)

1. Lightly pack each soil into its can or lamp chimney, filling to the same level.
2. Fill the measuring jars with water to the top level.
3. Place the cans of soil over the collecting beakers.
4. Pour water from the measuring jars, flooding the surface of the soils at first; then slowly add water to the moist surface until the cans begin to drip.
5. Measure the amount of water added and the time required.
6. Note the bubbles of air rising through the soil as water is added.
7. Add the rest of the water to both the soils.
8. Measure the amount of water that has passed through the soils.
9. Record your observations on the chart below:

	Time soil begins dripping	Amount of Water Added	Time soil Stops dripping	Amount of Water in the beaker
SOIL "A"				
SOIL "B"				

RESULTS:

1. Which soil begins to drip water first?
2. Which soil stops dripping first?
3. Which soil held the most water?

OTHER THINGS TO DO:

Test other kinds of soils and compare results.

III. IDEA C-4

STUDENT MATERIALS

PART I - Determination of Capillary Moisture

SOIL USED				
HORIZON	A	B	A	B
DEPTH, INCHES				
CAN NUMBER				
1. Weight of can				
2. Weight of can and moist soil				
3. Weight of can and air-dry soil				
4. Weight of water lost (line 2 minus line 3)				
5. Weight of water free soil (Part B, line 10)				
6. Per cent of Capillary moisture (line 4 divided by line 5) x 100				

PART II - Determination of Hygroscopic Moisture

7. Weight of can and air-dry soil (line 3)				
8. Weight of can and water free soil				
9. Weight of water lost (line 7 minus line 8)				
10. Weight of water-free soil (line 8 minus line 1)				
11. Per cent of Hygroscopic moisture (line 9 divided by line 10) x 100				

PART III - Total Moisture

12. Per cent Capillary moisture (line 6)				
13. Per cent Hygroscopic moisture (line 11)				
14. Total moisture per sample (line 12 plus line 13)				

III. IDEA C-4
Activity (2)

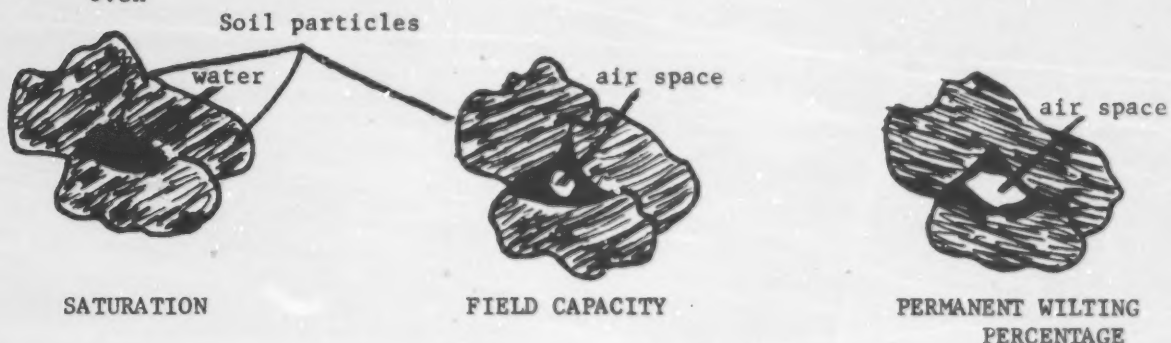
STUDENT MATERIALS

PROBLEM:

Are there different types of soil moisture?

MATERIALS:

Soil samples from moistured soils in previous exercise on moisture.
Empty cans and lids
Gram scale
Oven



STUDENT ACTIVITIES:
(Activity II)

PART I - Capillary Moisture

1. Weigh empty cans and lids.
2. Add soil and weigh cans and lids.
3. Place lids under cans and set cans on table to air dry.
4. Weigh cans each laboratory period until weight becomes constant. The difference between the starting weight and the air-dry weight is calculated as the per cent capillary water.

PART II - Hygroscopic Moisture

1. Place air dry samples in oven with lids below cans and dry at 105 degrees to 110 degrees C. (Above the boiling point of water).
2. Next laboratory period, place lids on cans, cool and weigh.
3. Calculate loss of water by oven drying. This is hygroscopic moisture.

PART III - Total Moisture

1. The per cent of capillary and hygroscopic moisture will be equal to the total moisture content of the soil at time of sampling.

Record data collected on Part I, Part II and Part III on charts on next page.

III. IDEA C-4

STUDENT MATERIALS

RESULTS:

1. Which soil in this exercise has the highest water holding capacity? Why?
2. Is all of the moisture in a soil available to a plant?
3. What type of moisture is lost by the air drying of soils?
4. Is all of the moisture which the soil originally contained lost during air drying? Explain.
5. Would the season of the year when the soils were air-dried influence the results? Explain.
6. Name four ways in which moisture is lost from the soil in the field.
7. Why isn't gravitational moisture measured by this procedure?
8. What is the difference between gravitational moisture and run off?
9. Why do many crops grow poorly in inadequately drained soils?
10. What effect does soil cultivation have on the loss of soil moisture?

OTHER THINGS TO DO:

Grow plants in the soils tested and record rate of growth.

III. IDEA C-5

TEACHER MATERIALS

CONCEPTUAL THEME:

All living and non-living things are in a constant state of change; nothing is static.

IDEA C:

The earth's surface is in a continuous state of change.

BACKGROUND INFORMATION:

Soil is a porous material composed of particles of many different sizes touching each other at certain points. The space not occupied by the particles themselves constitutes a large portion of the volume of the soil. This space is called pore space. It is in this pore space that water is stored. The soil in which most of the roots of a tree are growing may be likened to a reservoir containing various amounts of water at different times of the year.

After an irrigation, the soil throughout the portion wetted is at uniform moisture content as far as can be detected by sampling. When all of the pore space between particles of soil is filled with water for a short time, we say the soil is saturated. When drainage takes place, some of the water will move downward and, to a lesser extent, laterally by gravity. The water moving downward is called gravitational or free water. The water held by the soil after drainage takes place is called field capacity. At field capacity each soil particle is completely surrounded by water. Some water in the soil is capable of moving by capillarity. This is sometimes called capillary moisture, and its movement is very limited. The portion of water in the soil which is unable to move by capillarity is called hygroscopic moisture. In some cases plants may be able to use hygroscopic water and in some cases not; in others they cannot use all the capillary moisture and still others may use gravitational water.

Field capacity is influenced by a number of factors, such as, texture, structure, uniformity, humus and depth.

PROCESSES OR ACTIVITIES:

Collecting, Measuring, Comparing and Recording

STUDENT OBJECTIVES:

1. How water moves and penetrates soils.
2. How capillary water moves through soil.

RESOURCES:

Ayres, Quincy C. Soil Erosion and Its Control. McGraw-Hill, 1936. Jacks, Graham V. and R.O. Whyte. The Rape of the Earth: A World Survey of Soil Erosion. London: Faber and Faber, 1939.

III. IDEA C-5

STUDENT MATERIALS

PROBLEM:

How does water move through soils?

MATERIALS:

Wide mouth fruit jars (2 per student)
Soil samples of clay and sand for each student (brought from home areas, if possible).
Three pint jars per student
Two small pots for each student ($3\frac{1}{2}$ " outside diameter)
One package of food coloring
Small pieces of screen for each pot

STUDENT ACTIVITIES: (Activity I)

Using the steps outlined below fill a 3" clay pot to within one inch of the top with a sand-type soil, another with silt or loam type soil, and a third with clay type soil. Place each pot in a wide-mouth fruit jar. Time each to see how long it takes for a given amount of water to go through the soil in the pot. Water goes through sand fastest, loam second fastest and clay slowest.

1. Use samples of sandy soil and clay brought to class by students.
2. Each student should have two clay pots. In one pot place the sandy soil and in the other pot place the clay soil. Before adding the soil, place a piece of screen over the hole in the bottom of the pot. Fill the pots to within one inch of the top.
3. Place each of the two pots in the top of the two fruit jars.
4. Fill the three pint jars so they all have exactly the same amount of water; add a couple of drops of food coloring to each jar to give better contrast.
5. Pour the colored water from one jar into the pot containing the sandy soil. Pour slowly until a drop of water starts to form on the bottom of the pot. Repeat this with the pot containing the clay soil.
6. Compare the water remaining in each of the two jars with the third jar which remains as the check jar. The difference indicates the water holding capacity of each of the two sample soils.
7. After the water holding ability of the soil has been observed continue adding the water to each pot. Record the starting time of the pouring. Pour until the pint jars are empty. When the water has stopped dripping from the bottom of the pot, record the time again. The record of time can be kept in a simple chart, such as below. The difference in time will give a measure or indication of the movement of water in the different samples of soils.

Chart for Recording Water Holding Data

Pots	Starting Time	Ending Time	Difference
Sandy Soil			
Clay Soil			

STUDENT MATERIALS

RESULTS:

1. Why did the water run through some samples faster than others?
2. Which soils retained the most moisture?
3. Which soils would need irrigation most often?
4. Explain why the water moves laterally as well as vertically.

III. IDEA C - 5

STUDENT MATERIALS

PROBLEM:

How does capillary water move through soil?

MATERIALS:

Three glass columns or old-fashioned chimneys.
Three small pans or low wide-mouth glass jars.
Some thin cloth and some string or rubber bands.

STUDENT ACTIVITIES: (Activity 2)

1. Fasten the cloth over the top of the lamp chimneys or the cylinders. Turn them upside down and fill each $\frac{3}{4}$ full with one of the following dry soils:
 - a. Sand
 - b. Clay soil. This kind of soil is sticky when wet, and it dries in hard clods. Grind up the clods and put the dry clay in the cylinder.
 - c. Dark crumbly soil like that found under good grass sod. You can get topsoil from a garden or commercial nursery.
2. Jar the cylinders slightly by bumping on a table to settle the soil. Be sure the soils are dry.
3. Set the cylinders in the jars and pour water in the jars; do not pour water into the cylinders.
4. Keep a record of how long it takes the water to move up 1 inch, 2 inches, and 3 inches in each cylinder. Note how long it takes for the water to reach the top or whether it ever reaches the top.

Note: The idea is to compare the capillary movement of water in coarse, medium and fine soils.

Chart for Recording Measurements

Jars, Lamp Chimneys	1 inch	Time	2 inches	Time	3 inches	Time	Top	Time
Sand								
Clay								
Dark Soil (Loam)								

- RESULTS:
1. In which soil did the capillary action move the fastest? Why?
 2. In which soil did it move the slowest? Why?
 3. Which soil took the most water out of the jar?

III. IDEA C-6

TEACHER MATERIALS

CONCEPTUAL THEME:

All living and non-living things are in a constant state of change; nothing is static.

IDEA C:

The earth's surface is in a continuous state of change.

BACKGROUND INFORMATION:

On land that must be cultivated and cannot be kept in grass all the time, farmers can keep the land covered as much of the time as possible by using crop rotations. By growing a cultivated crop like corn, followed by a small grain crop and one or more years of grass-legume meadow, the land can be covered much of the time. Mulches can help in gardens.

PROCESSES OR ACTIVITIES:

Collecting, Observing, Measuring and Recording.

STUDENT OBJECTIVES:

To state the reasons why cover crops increase water absorption and prevent erosion.

RESOURCES:

Ayres, Quincy C. Soil Erosion and Its Control. McGraw-Hill, 1936.

Jacks, Graham V. and R. O. Whyte. The Rape of the Earth: A World Survey of Soil Erosion. London: Faber and Faber, 1939.

III. IDEA C-6

STUDENT MATERIALS

PROBLEM:

How do cover crops increase water absorption and prevent erosion?

MATERIALS:

1. Two small boxes about 16 inches long, 12 inches wide, and 4 inches deep. (Make water tight by lining with plastic material, tin, or tar paper.)
Note: At one end of each box cut a V-notch 1 to 1½ inches deep and fit with a tin spout to draw run-off water into a container.
2. Two flower sprinklers, at least a quart in size (or half gallon).
3. Two half gallon wide mouth fruit jars.
4. Two sticks of wood about 1 inch thick.

STUDENT ACTIVITIES:

1. Cut a piece of sod from a pasture, lawn, fence row, or the like, to fit one of the boxes. Trim the grass with scissors so that it is not more than an inch high. This makes it easier to handle.
2. Fill the other box with soil from the same place except be sure it does not contain grass, but don't try to pick a very poor soil. The idea is to have the same kind of soil in both boxes - one with grass, the other bare.
3. Set the boxes on a table so that the spouts extend over the edge; place the sticks under the other end to give them slope.
4. Put the empty fruit jars on stools placed beneath the spouts.
5. Fill the two sprinklers with water and pour the water on both boxes at the same time. Pour steadily and at the same rate for both boxes. Hold the sprinklers the same height from the boxes, about a foot will be satisfactory, although you can get various results with different heights.
6. Record findings below.

Boxes	Time Water Ran Off	Time Water Stopped	Water Color	Water Amount
COVER CROP				
BARE SOIL				

RESULTS:

Describe what you saw and list reasons why cover crops conserve water and soil.

III. IDEA C-7

TEACHER MATERIALS

CONCEPTUAL THEME:

All living and non-living things are in a constant state of change; nothing is static.

IDEA C:

The earth's surface is in a continuous state of change.

BACKGROUND INFORMATION:

When rain or irrigation waters are applied to fields, they may soak or penetrate the top-layer of soil very easily, but in many cases they are slowed to a snail's pace by a plow pan (hard pan) that prevents the rapid flow of water downward. This condition brings about excessive run-off and loss of water to the deep-strata area.

Farming the depths-- the third dimension--opens up hard subsoils and lets water soak in, thereby raising the water table.

PROCESSES OR ACTIVITIES:

Measuring and Recording and Describing

STUDENT OBJECTIVES:

State how deep-tillage improves moisture penetration, improves plant growth, and conserves soil and water.

RESOURCES:

Ayres, Quincy C. Soil Erosion and Its Control. McGraw-Hill, 1936.

STUDENT MATERIALS

PROBLEM:

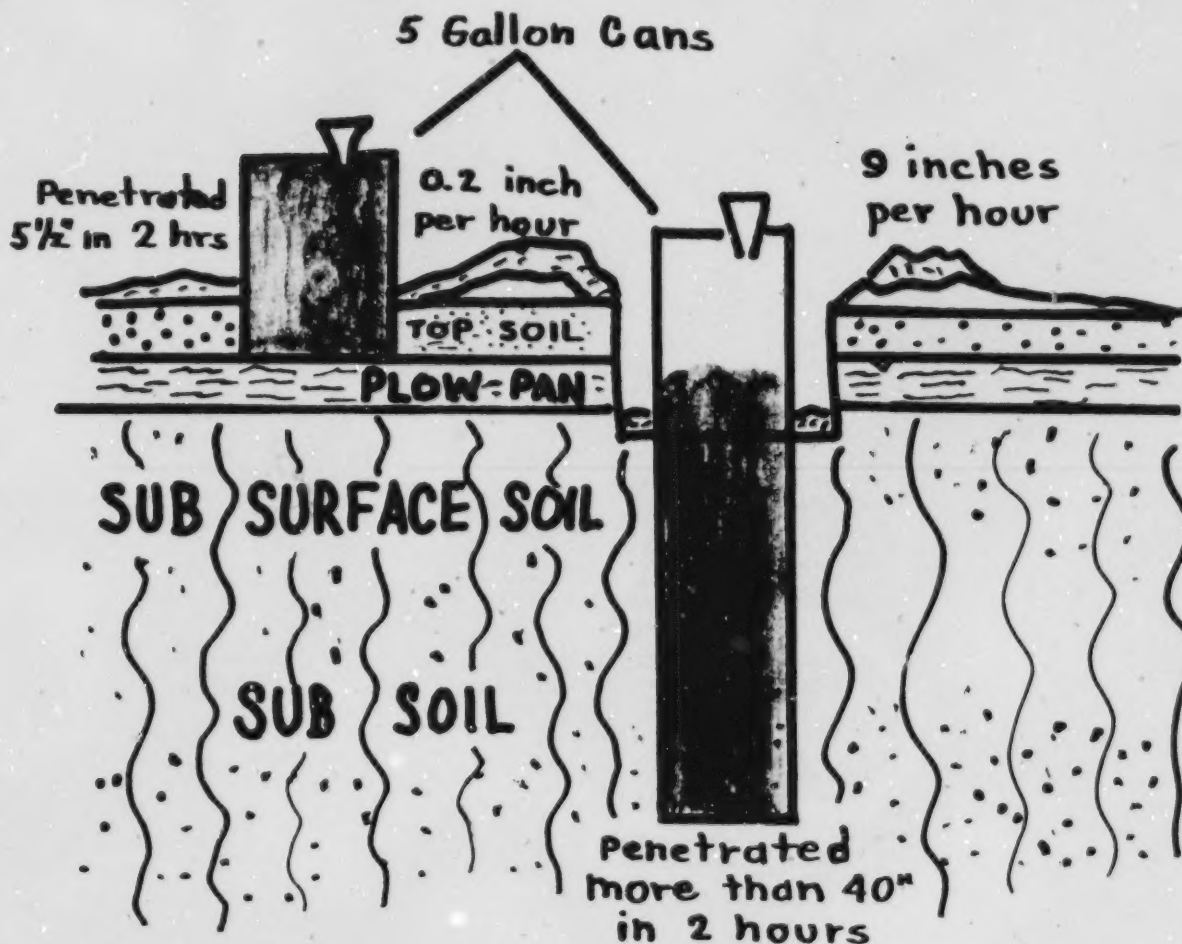
How does deep-tillage improve moisture penetration?

MATERIALS:

1. Two infiltrometers - or 5 gallon cans cut out at both ends
2. Quart measure
3. Pencil and paper
4. Watch with second hand
5. Five gallons of water

STUDENT ACTIVITIES:

Place the infiltrometer or cans in soil. Place one on the top of the plow pan (hard pan) and the other an inch below the plow pan. (See diagram below). Pour equal amounts of water in each can and record time it takes for water to be displaced. You can add more water if you wish. Generally one gallon is sufficient.

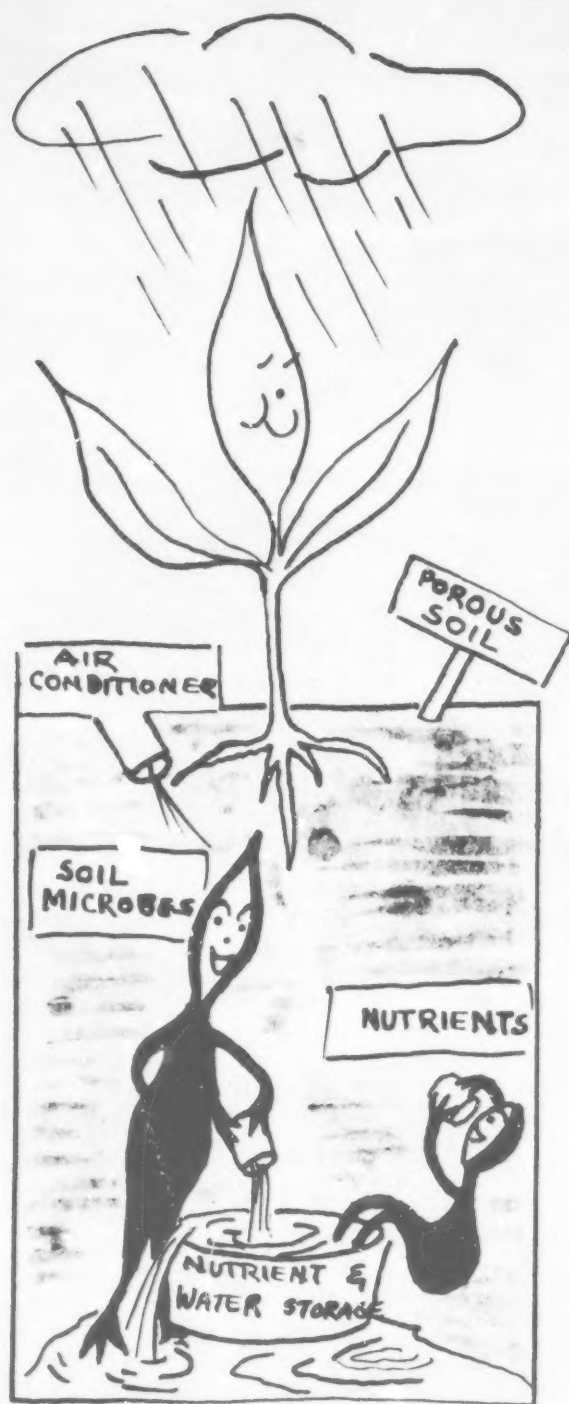


III. IDEA C-7

STUDENT MATERIALS

RESULTS:

1. What was the time it took to displace the sample on the top of the plow pan? _____
2. What was the time it took to displace the sample an inch below the plow pan? _____
3. Explain how the storage of moisture is affected by subsoiling.
4. Explain how subsoiling affects the following:
 - a. Root development
 - b. Drainage
 - c. Runoff and erosion
 - d. Soil temperature
 - e. Aeration



III. IDEA C-8

TEACHER MATERIALS

CONCEPTUAL THEME:

All living and non-living things are in a constant state of change, nothing is static.

IDEA C:

The earth's surface is in a continuous state of change.

BACKGROUND INFORMATION:

There is often much abuse committed in watering plants whether it be by the home gardener or by farm irrigation. Much of this abuse is from a lack of understanding of soils and how plants grow. Texture of soil and plant needs are all important. Over-watering which fills all the pore space in the soil and leaves no air space is as detrimental as under-watering and allowing the plants to wilt and die. A simple rule to follow is: Water thoroughly and infrequently. One has to remember that there is very little lateral movement of water in the soil as most water penetrates straight down. One of the basic and little understood facts about watering is that "A little water wets only a little soil; you can't half-water soil." Water moves down through the soil by progressively satisfying the water-holding capacity of every soil particle.

As indicated, soil texture is very important in knowing how much water to apply. A general rule of thumb is that 1 inch of rain or 1 inch of water evenly applied will penetrate sandy soil 12 inches, loam soil 7 inches and clay soil 4 to 5 inches.

Weather, including temperature and humidity, also has a great bearing on how often to irrigate.

PROCESSES OR ACTIVITIES:

Measuring, Observing and Interpreting

STUDENT OBJECTIVES:

1. To determine the amount of water put out by a sprinkler irrigation system in a given time.
2. To see how deeply the water penetrated the soil.

RESOURCES:

Donahue, R. L. Soils: An Introduction to Soils and Plant Growth. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1958.
Irrigation on Steep Land. Circular 509. University of California Extension Service.
Sunset Western Garden Book. Lane Publishing Company, Menlo Park, California.

III. IDEA C-8

STUDENT MATERIALS

PROBLEM:

How to water correctly using sprinklers.

MATERIALS:

A number of straight side cans such as coffee cans
Rulers
Sprinklers to be used in sprinkler irrigation
Shovel
Soil probe

STUDENT ACTIVITIES: (Activity I)

1. Using either permanent sprinkler system or movable sprinkler system, select area to be sprinkled.
2. Place a series of cans, at equal distances, across area to be sprinkled.
3. Turn on sprinklers and allow to run for half an hour, and then measure amount of water in the cans with a ruler. Repeat after allowing the sprinklers to run one hour.
4. Test soil with shovel or soil probe to see how deeply the water has penetrated. If the soil is dry below a certain point, the probe will be hard to push into the soil.

RESULTS:

1. What was the penetration of the water after half an hour? After one hour?
2. How much water was collected after half an hour? After one hour?

OTHER THINGS TO DO:

1. Repeat the above on a different type of soil and compare results.
2. Let sprinklers run for longer periods of time and compare results.
3. Decide the correct time of sprinkling for each type of soil tested.

III. IDEA C-8

STUDENT MATERIALS

PROBLEM:

How to water using water soakers.

MATERIALS:

Burlap sack
Garden hose
Soil probe
Canvas or plastic soaker hoses may also be used
Ruler

STUDENT ACTIVITIES: (Activity II)

1. Tie a burlap sack onto the end of the garden hose, placing covered end on ground.
2. Turn water on and let it seep slowly. (This method may be used for spot watering such as around rose bushes, melons, tomatoes, etc., where it is best not to water the plant itself).
3. After one half to one hour move burlap sack to a new area.
4. With soil probe, check to see how deeply the water has penetrated.

RESULTS:

1. How deeply did the water penetrate at the end of the garden hose?
2. How did the depth of penetration vary as you probed a foot away from the end of the hose? Two feet? Three feet?

OTHER THINGS TO DO:

1. Increase the flow of water from the garden hose and measure results and compare with above results. (This can be done by either opening the valve more or using a larger hose or a combination of both).

III. IDEA C -8

STUDENT MATERIALS

PROBLEM:

How to water correctly by flooding the area.

MATERIALS:

Large water hose (1 inch or larger)
Round point shovel
Soil probe

STUDENT ACTIVITIES: (Activity III)

1. Be sure area to be irrigated is level or nearly level. If there is a slope, it should be opposite the end where the water enters.
2. Throw up borders of soil around the area to be irrigated. The borders should be high enough, large enough, and strong enough to hold the water in the area to be irrigated.
3. Turn water into area and allow it to run until the entire area is covered.
4. After turning water off, check depth of penetration with a shovel or soil probe. This method is used in irrigating solidly planted crops such as alfalfa, barley, wheat and oats. Some lawns are also set up to irrigate this way.
5. When watering with this method, one has to be sure water does not stand on a part of the area for a very long period of time. Remember, plant roots need air as well as water.

RESULTS:

1. What was the penetration of the water?
2. Did the water soak into the soil fast or slow?
3. Did you get approximately the same penetration by the water over the entire area flooded?

OTHER THINGS TO DO:

1. Perform this type of irrigation on different plants and vary the amount of time flooded and record results.

III IDEA C-9

TEACHER MATERIALS

CONCEPTUAL THEME:

All living and non-living things are in a constant state of change; nothing is static.

IDEA C:

The earth's surface is in a continuous state of change.

BACKGROUND INFORMATION:

The properties of soil will vary with its composition, its moisture content, its vertical position in relation to the surface of the ground, and its geographical location. Most soils were originally solid rock. Time and climate have broken the rock into progressively smaller grains.

PROCESSES OR ACTIVITIES:

Observing, Analyzing and Classifying.

STUDENT OBJECTIVES:

To observe, analyze, and classify the soil particles or "soil separates" contained in the parent material after various degrees of pulverizing. Classify first, sand sized grains, then silt-sized grains, and finally clay-sized grains.

RESOURCES:

Beeler, Nelson F. and Franklyn M. Branley. More Experiments in Science. Isgur. An Introduction to Soil Science - Lessons on Soil. 1938.
U.S.D.A. Soil Conservation Service. Soil and Water Conservation Activities for Boy Scouts.
Worthren and Aldrich. Farm Soils. 1956.

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III. IDEA C-9

Activity (1)

STUDENT MATERIALS

PROBLEM:

What effect do time and climate have on the formation of soil?

MATERIALS:

Two or three pieces of calcareous gravel or stone

Hammer

Mortar and pestle

STUDENT ACTIVITIES:

Take two or three pieces of calcareous gravel or stone and pulverize with the mortar and pestle. First, sand-sized grains can be made, then silt-sized grains, and finally clay-sized grains. However, as nature reduces rock into finer grains, chemical changes also take place. Separate the different size particles and classify them as to sand, silt or clay.

RESULTS:

Is there a relationship between the kind of parent material and the amount of soil separates?

Is there a relationship between the time that the parent material was being pulverized and the size of the soil separates?

Can soil be formed faster in the laboratory than in nature?

OTHER THINGS TO DO:

What other forces of nature might act as soil formers?

III. IDEA C-9
Activity (2)

STUDENT MATERIALS

PROBLEM:

What effect do time and climate have on the formation of soil?

MATERIALS:

Limestone or fine sandstone
Old brick or concrete
Piece of white paper and a spoon

STUDENT ACTIVITIES:

Rub two pieces of limestone together. You can use a couple of pieces of old brick or concrete. Notice how long it takes to rub off even a few particles.

RESULTS:

Does it take a long time to accumulate a spoonful?

What do you think happened when glaciers moved over the land thousands of years ago?

OTHER THINGS TO DO:

Where are glaciers active today?

III. IDEA C-9
Activity (3)

STUDENT MATERIALS

PROBLEM:

What effect do time and climate have on the formation of soil?

MATERIALS:

Hot plate
Limestone fragments
Ice water and a pan

STUDENT ACTIVITIES:

Heat a small piece of limestone over a flame or hot plate.
Drop it quickly into a pan of ice water.

RESULTS:

What happened to the limestone when it was dropped into the ice water?
What happens when the sun warms the rocks during the day and at night
the rocks cool?

III. IDEA C-9
Activity (4)

STUDENT MATERIALS

PROBLEM:

What effect do time and climate have on the formation of soil?

MATERIALS:

Small coffee can with lid
Small medicine bottle with screw-type lid
Chipped ice
Salt
Water
Refrigerator

STUDENT ACTIVITIES:

Place chipped ice and salt in coffee can. Fill medicine bottle completely full of water. Screw on bottle lid. Place the prepared bottle of water into the can of chipped ice. Cover can. Bottle can be placed in the freezer compartment of a refrigerator.

RESULTS:

What happened to the shape of the coffee can?
What happens to water that finds its way into cracks in rocks in cold regions of the world? What happens to the rocks?

OTHER THINGS TO DO:

How do soil particles carried by water or wind act as a soil building force?

III. IDEA C-9
Activity (5)

STUDENT MATERIALS

PROBLEM:

What effect do time and climate have on the formation of soil?

MATERIALS:

250 cc beaker
Vinegar
Limestone
Hot plate

STUDENT ACTIVITIES:

Put some small pieces of limestone in a little vinegar. Heat the vinegar on a hot plate or over a burner. Notice how bubbles form on the piece of stone.

RESULTS:

What are the bubbles? (Hint: Plants give this off in the soil)
What happened to the limestone? Why?
How can this process take place in a soil where there is carbon dioxide and soil moisture? (Hint: What is formed from water and carbon dioxide?)

OTHER THINGS TO DO:

Find out if water or carbonated water will dissolve the lime in limestone faster.

III. IDEA C -10

TEACHER MATERIALS

CONCEPTUAL THEME:

All living and non-living things are in a constant state of change, nothing is static.

IDEA C:

The earth's surface is in a continuous state of change.

BACKGROUND INFORMATION:

The temperature of the soil is extremely important, inasmuch as it affects crop adaptation, germination, growth, and maturation of crops, and the activities of soil microorganisms associated with decay of organic matter and transformations of mineral nutrient elements. The temperature of the soil, in turn, is affected by the amount of solar radiation and the amount which may be absorbed.

The slope of the soil determines the angle of incidence of solar radiation and the intensity of the radiation thus received. The color of the soil will influence the extent to which the radiation is absorbed or reflected, dark soils being much better absorbers than light soils. Moisture affects the rate of soil warm-up, since it has such a high heat capacity or a high specific heat. It takes approximately five times as much heat energy to raise the temperature of a given amount of water one degree Centigrade as it does a comparable amount of dry soil.

A vegetative cover influences soil warm-up, in that it may shield the soil from the solar radiation.

PROCESSES OR ACTIVITIES:

Measuring, Observing and Interpreting

STUDENT OBJECTIVES:

To determine the effect of slope, color, and moisture content on soil temperature.

III. IDEAL C-10

STUDENT MATERIALS

PROBLEM:

What is the effect of slope, color, and moisture content on soil temperature?

MATERIALS:

Heat lamp
Soil trays
Calcium carbonate or other whitening material
Carbon black or other darkening material
Thermometers

STUDENT ACTIVITIES:

1. Fill six trays with soil and then treat as follows:

- a. Natural color, moist, north slope.
- b. Natural, moist, flat.
- c. Natural, moist, south slope.
- d. Natural, dry, south slope.
- e. Black, moist, south slope.
- f. White, moist, south slope.

Note: All moist samples should be at or near the field capacity.

2. Set up the heat lamp so that it faces directly the south slope samples and is approximately equidistant from all of the samples; or, if the weather is favorable, place the samples out of doors.
3. Place thermometers in each of the soil samples and take readings each half hour if placed indoors, or each hour if placed out of doors. Plot the changes which occur in each of the samples.

RESULTS:

Temperature Relationships

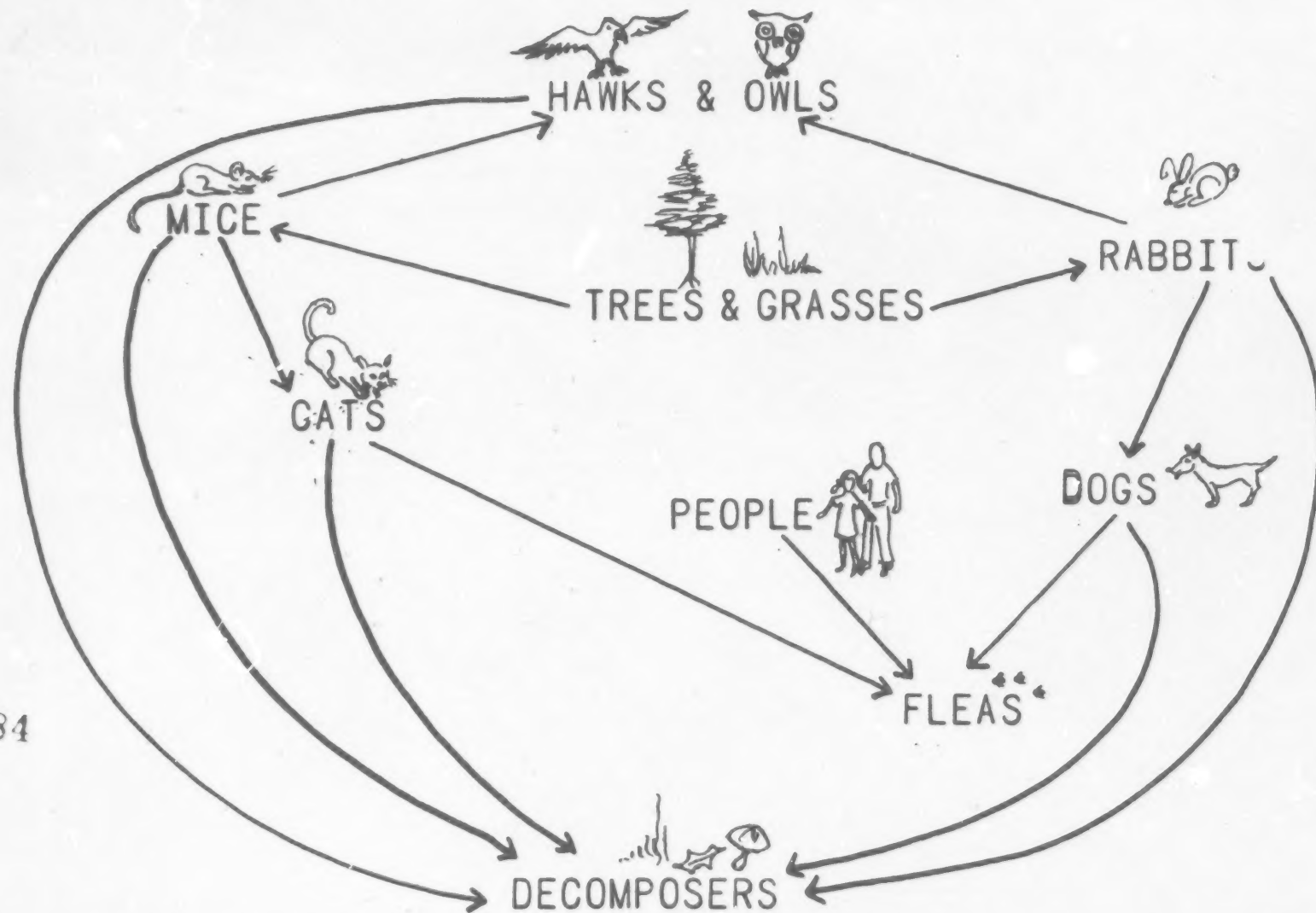
Sample No.	Description	Temperature at given time					

III. IDEA C -10

STUDENT MATERIALS

1. What effect does color have on soil warm-up?
2. What is the practical application of this fact?
3. Which of the three factors was most influential in determining soil warm-up?
4. Which of these factors may be changed under field operation?
5. What is meant by specific heat of soils. How does its value compare with that of water?
6. While dark materials absorb more heat than do light materials, why is it that dark soils generally warm up more slowly than light soils?

"PEOPLE ARE SCRATCHING" FOOD WEB



III. IDEA E-1

"PEOPLE ARE SCRATCHING"

TEACHER MATERIALS

CONCEPTUAL THEME:

All living and non-living things are in a constant state of change; nothing is static.

IDEA E:

Rapid environmental or hereditary changes may cause chain-reactions resulting in the extinction of or unwanted changes in organisms.

BACKGROUND INFORMATION:

This song, "People Are Scratching", is available on record from the contact unit, Environment: Earth in Crisis, published by Scholastic Magazine, Inc.

A sample food web is presented on the reserve of this page which can be used to make an overhead transparency (using infrared sheet) to be used for comparison with students' food webs.

Discussion of this song and food web can extend to:

1. population control by predation
2. Man's intrusion
3. Use of pesticides
4. Financial aspects of feed (for rabbits) vs pesticides, etc.

PROCESSES AND ACTIVITIES:

Diagramming, Value clarification

STUDENT OBJECTIVES:

1. To diagram an energy flow chart
2. Recognition of trophic levels
3. Clarification of value of wildlife vs human convenience.

III. IDEA E-1

STUDENT ACTIVITIES:

- I. Sing this song, or read it as a poem.

THE PEOPLE ARE SCRATCHING
by Ernie Marrs & Harold Martin

1. Come fill up your glasses and set yourselves down,
I'll tell you a story of somebody's town.
It isn't too near and it's not far away
And it's not a place where I'd want to stay.

Chorus:

- The people are scratching all over the street
Because the rabbits had nothing to eat.
2. The winter came in with a cold icy blast,
It killed off the flowers, and killed off the grass.
The rabbits were starving because of the freeze
And they started eating the bark on the trees.
 3. The farmers said, "This sort of thing just won't do,
Our trees will be dead when the rabbits get through;
We'll have to poison the rabbits, it's clear,
Or we'll have no crops to harvest next year."
 4. So they bought the poison and spread it around
And soon dead rabbits began to be found.
Dogs ate the rabbits, and the farmers just said,
"We'll poison those rabbits till the last dog is dead."
 5. Up in the sky there were meat-eating fowls
The rabbits poisoned the hawks and the owls,
Thousands of field mice the hawks used to chase
Were multiplying all over the place.
 6. The fields and the meadows were barren and brown,
The mice got hungry and moved into town.
The city folks took the farmers' advice
And all of them started to poison the mice.
 7. There were dead mice in all the apartments and flats,
The cats ate the mice, and the mice killed the cats.
The smell was awful, and I'm glad to say
I wasn't the man hired to haul them away.
 8. All through the country and all through the town
There wasn't a dog or a cat to be found;
The fleas asked each other, "Now where can we stay?"
They've been on the people from then till this day.

III. IDEA E-1

9. All you small creatures that live in this land,
Stay clear of man with the poisonous hand!
A few bales of hay might keep you alive,
But he'll pay more to kill you than to let you survive.

II. Draw a food web showing the flow of energy through the organisms in this song. Answer the questions on the following page.

III. Answer and Discuss these questions:

1. What alternative did the farmers have to poisoning the rabbits?
2. In the natural environment, what population control checked the number of mice?
3. Why did the mice migrate?
4. On which trophic level are the mice?
5. On which trophic level are the fleas?
6. Which interspecific relationship is shown between the fleas and dogs?
7. Which interspecific relationship is shown between the hawks and mice?
8. Find other instances of man's disturbing food webs which result in his own loss.

IV. IDEA B-1

TEACHER MATERIALS

CONCEPTUAL THEME VI:

Natural resources and ecological systems have specific capabilities and limitations.

IDEA B

Man-made environments are maintained in a steady state through the continuous care and expenditures of energy by man.

BACKGROUND INFORMATION:

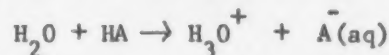
This experiment utilizes color indicators to determine pH. Before a discussion of indicators is appropriate, students must first understand pH. pH is the measurement of the concentration of the hydronium ion (H_3O^+) and is defined mathematically by the following equation.

$$\text{pH} = - \log_{10} (\text{H}_3\text{O}^+)$$

In general terms pH is said to describe acid properties which correspond to the numerical values from less than 1 to 7. A pH of 7 is considered to be neutral. As the numerical value of pH increases the acid content of the solution decreases. A sample calculation might be useful.

A .1 M (Molarity=moles/Liter) monoprotic acid and a .001 M monoprotic acid are compared:

Assume for this acid we find 100% ionization according to the equation:



It is obvious that .1 mole of the acid molecules will produce .1 mole of the hydronium ion. Now we can calculate pH.

$$\text{pH}/.1 \text{ M of the acid} = - \log_{10} (\text{H}_3\text{O}^+) = - \log_{10} (10^{-1}) = -(-1) = 1 \text{ strong acid}$$

$$\text{pH}/.001 \text{ M of the acid} = - \log_{10} (\text{H}_3\text{O}^+) = - \log_{10} (10^{-3}) = -(-3) = 3 \text{ weaker acid}$$

At pH values above 7 to approximately 14 the solution contains "basic" properties or the concentration of the H_3O^+ ion is smaller than 10^{-7} M .

This laboratory can initiate many discussions of how pH relates to quality of water and the quality of life in that water. Because of the presence in solution of carbonate and bicarbonate ions, the pH of most productive, fresh natural waters is between 6.5 and 8.5. This natural buffer system makes it possible for small amounts of acid or base to dissolve in the waters without causing appreciable changes in the pH of that water.

These ions produce a reservoir of carbon for plant growth, however, there is a limited amount of these ions in natural waters since there is a decided limit on the rate at which CO_2 , the source of carbonate and bicarbonate, can be obtained from the atmosphere.

IV. IDEA B-1

Large influxes of strong acid will overwhelm the buffering action of natural waters and make drastic changes in the pH of that system. Experimentally several facts have been collected for water systems:

1. At pH levels below 4.0 all vertebrates, most invertebrates and many microorganisms are destroyed.
2. At pH levels below 6.0 water can cause excessive corrosion of plumbing systems, boats, piers or anything with metal as part of the structure.
3. At pH levels below 4.5 irrigation water can produce toxic substances in the soil by dissolving substances such as Fe, Al and Mg salts.

Acidic industrial pollution can kill fish and other aquatic life by converting the carbonate and bicarbonate ions into free carbon dioxide which interferes with the process by which carbon dioxide is eliminated from the animals. The result is an internal increase of carbon dioxide in the animal's blood stream and a subsequent decrease in the oxygen level. These conditions lead to the eventual death of the animal.

A complete discussion of indicators is not necessary since the chemistry of the indicator is not the point of this laboratory. It will be sufficient to demonstrate the colors of bromothymol blue at various pH's. Wide range pH paper is simply an indicator (actually a mix of indicators) that has been impregnated into the paper.

SPECIFIC PROCEDURE:

pH color comparisons are best done visually with stock samples of known hydronium ion concentrations (dilution of acid) or color replicas of those solutions. If stock samples are used, place the sample to be analyzed next to the stock sample in your hand. Add the indicator drop-wise and in the same amount to both tubes. This method of comparing color is very subjective and leaves some room for error, therefore, it is most effective if compared with a lab partner's results to check for accuracy in comparing color.

A teacher demonstration with an "unknown" sample and several prepared standards will help students comprehend the procedure. First check the pH of the "unknown" water sample with wide-range pH paper. Next obtain the appropriate standards to bracket this range. Finally line up the standards in similar glass test tubes and add the appropriate number of indicator drops. Now compare color in the tubes to the color of the unknown sample prepared with the indicator in the same manner.

IV. IDEA B-1

PROCESS OR ACTIVITIES

Observing, recording, and comparing

STUDENT OBJECTIVES:

1. Students will relate the concept of pH to color intensity of solution.
2. Students will compare environmental quality with the pH value of a solution of lake water.
3. Students will compare the pH of treated water (tap water) with water occurring naturally in their environment.

REFERENCES:

Stoker, Stephen H. and Seager, Spencer L., "Air and Water Pollution,"
Scott, Foresman & Co., Glenview, Ill., 1972, pp. 102-103.
Manahan, Stanley E., "Environmental Chemistry," Willard-Grant Press,
Boston, Mass., 1972.

IV. IDEA B-1

STUDENT MATERIALS

PROBLEM:

How can pH be an indication of water quality?

MATERIALS:

pH module to include:
bromothymol blue indicator
wide range pH paper standards
6 screw top test tubes with standards
comparator cell
test tubes
paper towel squares
Instruction card

STUDENT ACTIVITIES:

Background

The use of the pH module is simply a matter of comparison of color in established water standards already containing an indicator. The colors correspond to concentrations of the hydronium ion (H_3O^+) which is the ion responsible for acidic properties in water.

PROCEDURE:

Obtain a water sample clear of debris and fairly transparent. Pour part of the sample into the test tube. Transfer several drops of water to the wide range pH paper and check the pH range. Most water samples will fall between 6.5-8.5. If this is the case, add several drops of the bromothymol indicator and compare color in the color comparator cell until a color match is found.

Your teacher will demonstrate the color comparison method to be performed in this experiment.

Do Not Film This Page

IV. IDEA C-1

TEACHER MATERIALS

STUDENT OBJECTIVES:

1. Students will construct a device for random sampling of particulate air pollution.
2. Students observe data and interpret that data to predict a cause of pollution sampled on the particulate sampler.

REFERENCES:

Investigating Your Environment, Addison-Wesley, 1975, pp. 129-131
Air Pollution Experiments For Junior and Senior High School Science Classes,
Hunter and Wohlers, Air Pollution Control Assoc. 1969.

IV. IDEA C-1

TEACHER MATERIALS

CONCEPTUAL THEME: IV

Man-made environmental changes may change or destroy beneficial natural environments.

IDEA C:

Man-made environmental changes may change or destroy beneficial natural environments.

BACKGROUND INFORMATION:

Medium to large particles which range in size from 20 microns can be seen without magnification. These nuisance solids in the atmosphere account for most of the complaints about particulate pollution. This type of air pollution can do superficial damage such as soiling clothing, automobiles, and buildings or more serious physical damage to our lungs. This is definitely not the most harmful type of pollution but is a danger.

During the postlab of this experiment it might be interesting to find a picture of the "Cincinnati visual standards" for particulate pollution to show the class. Once the samples of particulate matter have been collected on the tape, mark the tape with the direction, student name, and location of the sampler. If several samplers were used a composite of the tapes could be made as a poster.

Your interpretation of this data may vary according to the reason for your investigation. Here are some things to consider in your evaluation:

1. Particles collected on the top of the jar represent those settling out of the air, while those on the sides were carried by the wind.
2. What would account for an uneven distribution of particles over the tape surface.
3. Are any sources of particulate pollution nearby?
4. Observation with a magnifying glass might show a relationship between the particles and give a clue to their origin.

PROCESSES OR ACTIVITIES:

Observing, recording, describing, predicting, and reporting.

IV. IDEA C-1

STUDENT MATERIALS

PROBLEM:

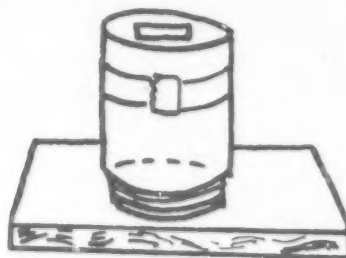
Air pollution in the form of particulate matter causes damage to our environment and health.

MATERIALS:

Cylindrical jar about 3" in diameter and 6" deep with screw lid
White sticky tape about 2" wide
Wooden base for the jar 5" by 8"
Wood Screws
Tin cans that will fit over the jars

STUDENT ACTIVITIES:

1. Assemble the apparatus.
 - A. Attach the jar lid to the wooden base with the wood screws and then attach the jar to the lid.
 - B. Place a 3" strip of white tape with the stick side out on the bottom of the jar.
 - C. Cut a strip of white tape long enough to wrap around the middle of the jar, sticky side out.
 - D. The completed particulate sampler should look like this:



2. Experimental Procedure:
 - A. Decide where you will collect samples. Samplers should be placed on rooftops or other locations that do not block the free circulation of air. Make sure you are aware of how the sampler is oriented; you might even mark north, south, east and west on your sampler for future reference.

- B. Construct a sufficient number of samplers for your study and before exposure to the atmosphere cover the sampler with a tin can to protect the adhesive coating.

3. Interpretation of Experimental Evidence

- A. Compare your strips of adhesive to those of your classmates for concentration of particles and size of particles.
- B. Attempt to explain the differences of concentration in terms of placement of samplers. Remember to check your area for a source of particulate pollution.

IV. IDEA C-2

TEACHER MATERIALS

CONCEPTUAL THEME: IV

Populations are affected by their environment and the environment is altered by the population.

IDEA A:

Man-made environmental changes may change or destroy beneficial natural environments.

BACKGROUND INFORMATION:

This experiment could launch your class into a complete lake study. This laboratory has two objectives. First to identify the nutrients that cause excessive and undesirable underwater plant growth. Then to determine the origin of these nutrients. The exercise will take some advanced planning but the results of collecting this type of data will be well worth the effort.

First you must prepare the necessary solutions for the "known" nutrients you will use in the groups first test tube. Prepare the stock solutions as follows:

Solution 1

Compound	Mass (g/ 1 liter)
KNO ₃	1.0
MgSO ₄ ·7H ₂ O	0.12
KH ₂ PO ₄	0.25

Solution 2

H ₃ BO ₃	2.86
MnCl ₂ ·4H ₂ O	1.81
ZnSO ₄ ·7H ₂ O	0.22
CuSO ₄ ·5H ₂ O	0.08
MoO ₃	0.02
Ca(NO ₃) ₂ ·4H ₂ O	59.0
COCL ₂ ·6H ₂ O	0.04

Solution 3

iron (III) citrate	5.30
citric acid	5.30

Solution 4

KCl	1.0
MgSO ₄ ·7H ₂ O	0.25
KH ₂ PO ₄	0.25

Solution 5

KNO_3	1.0
$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	0.12

Solution 6

Compound	Mass (g/ 1 liter)
5-10-10 fertilizer	1.77

Solution 7

Prepare the same as solution 2, but substitute $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ (36.8 g/ 1 liter) for $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$.

Next find students that can obtain the lake water, street run-off sample and lawn run-off sample. About 1 liter of each of these solutions should be adequate.

Finally set up and run the experiment. In about four weeks your results should help you build a profile of your area's water content and which ingredients encourage the growth of algae.

Here is a review of each of the four groups and their content in tube one.

Group I: The complete nutrient group: This group serves as the control or standard. All nutrients necessary for the growth of algae are present.

Group II: Low nitrogen group: All nutrients are present, however, the amount of nitrogen present is below that which will stimulate growth.

Group III: No phosphorus group: All nutrients are present except phosphorus.

Group IV: Fertilizer group: Nitrogen and phosphorus are present but trace elements are absent.

Test tubes 2, 3 and 4 should be compared to the control standards in test tube 1. After you have completed your results, students will probably wish to continue the study. Good follow up exercises can be found under water pollution in the Environmental Bibliography.

PROCESSES OR ACTIVITIES:

Measuring, observing, recording, comparing and inferring.

STUDENT OBJECTIVES:

1. Students will demonstrate the relationship between specific nutrients and plant growth.

2. Students will identify sources of nutrients that enrich local lakes.
3. Students will suggest methods for correcting the unnecessary enrichment of these lakes.

IV. IDEA C-2

STUDENT MATERIALS

PROBLEM:

Waste water and runoff from our homes, streets and industrial plants can have a negative effect on our natural ground waters.

MATERIALS:

Solutions 1-7 prepared by your instructor

8 test tubes per experiment

Cotton wadding

Pipets or graduate cylinders

80 ml of pond water

15-20 ml samples (possibly one person could acquire 1 liter of solution for the entire class)

- A. A sample of runoff water from a freshly fertilized yard.
- B. A sample of runoff water from the street just after a rain.
- C. A sample of discharge from a sewage plant or from an industrial discharge.

STUDENT ACTIVITIES

Procedure:

1. The class will be divided into four groups. Each group will feed its algae several nutrient solutions. One of the groups will add all the nutrients required for growth; the algae culture for the other three groups will each be lacking in some particular nutrient. Over the next three weeks you will observe the growth of algae in various test tubes.
2. Your instructor will assign you a group. Follow the instructions below pertaining to your group only!
 - A. Group I: This solution is the complete nutrient solution. Obtain five clean, dry test tubes and cotton wadding to insert in the top of the tubes. To the first test tube, add 10 ml of solution 1, 0.1 ml of solution 2, and 1 ml of solution 3. Swirl the test tube to mix the three solutions thoroughly and then add 0.5 ml of the pond water. Label this as tube 1, set 1. Take a second test tube and add 10 ml of the runoff sample to 5 ml of pond water. Repeat this procedure for the street sample and the industrial plant sample. Label these samples as tubes 2, 3, and 4 respectively. Finally add 10 ml of pond water to a clean, dry test tube and stopper it with cotton wadding. You should note that, in addition to the nutrients present in solution, the algae require carbon dioxide and light for photosynthesis. You can provide this by frequently swirling the solutions and placing them near a window to get sufficient light. Also mark the liquid level in the tubes and keep them constant by the addition of distilled water when necessary.

- B. Group II: This solution is the low nitrogen solution. Obtain five clean, dry test tubes and cotton wadding to insert in the top of the tubes. To the first test tube add 10 ml of solution 4, .1 ml of solution 3, and 1 ml of solution 7. Swirl the test tube to mix the solutions and then add 5 ml of pond water. Tubes 2 through 5 will follow the same procedure as the first group used; consult the procedure in part A.
- C. Group III: The first solution is the solution lacking phosphate. To the first test tube add 10 ml of solution 5, .1 ml of solution 2, and 1 ml of solution 3. Swirl the test tube to mix the three solutions thoroughly and then add 5 ml of the pond water. Tubes 2 through 5 will follow the same procedure as the first group used; consult the procedure in part A.
- D. Group IV: This solution contains a fertilizer equivalent to 5-10-10 fertilizer similar to that used on home lawns. To the first test tube add 10 ml of solution 6 and then 5 ml of the pond water. Tubes 2 through 5 will follow the same procedure as the first group used; consult the procedure in part A.
3. After three to four weeks compare the five test tubes in your group for the greatest amount of algae growth. Use tube 5, the control tube, for comparisons.
4. After completing the experimental part of the laboratory your instructor will explain what materials were in the first tubes (Group I-IV). The class will then be asked to conclude what substances are likely to cause algae to grow more rapidly in your area.

V. IDEA A-1

TEACHER MATERIALS

CONCEPTUAL THEME: V

Man's society is an interaction of custom, rule and law.

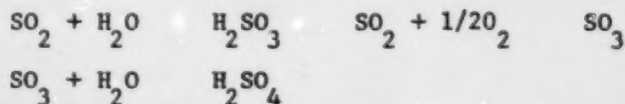
IDEA A:

Each individual has a vital role in helping maintain the environment so that it is suitable for all forms of life, including man.

BACKGROUND INFORMATION:

The combustion of sulfur to form the oxides of sulfur is not such an extremely remote occurrence as it might appear. Each day petroleum based fuels with a percentage of sulfur in their content add to the air pollution problem. The world is running short of low sulfur fuels and the effects of sulfur oxides should be known. Even the catalytic converter, a device that was intended to clean up the air by eliminating the use of leaded fuels, spews oxides of sulfur and the resulting acids of those oxides when they combine with water.

Here are some of the reactions that are possible when SO₂ sulfur dioxide is released into the atmosphere:



Note how sulfur dioxide and sulfur trioxide are acid anhydrides.

PROCESSES OR ACTIVITIES:

Observing, measuring, recording and interpreting.

STUDENT OBJECTIVES:

Students will demonstrate the effects of sulfur dioxide and its resulting acid on various things in their environment.

V. IDEA A-1

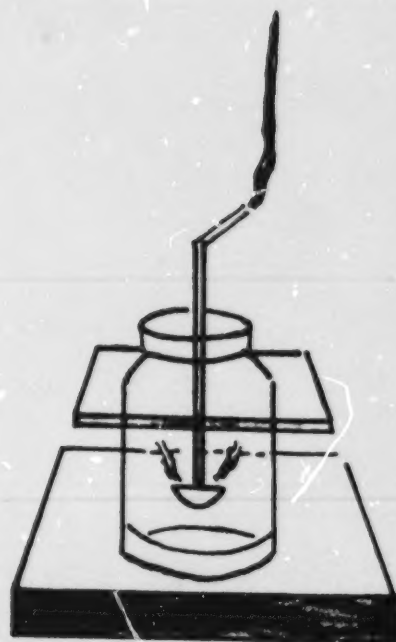
STUDENT MATERIALS

PROBLEMS:

Poor air quality in our environment can damage plant life, buildings, and clothing.

MATERIALS:

Glass bottles with a glass cover plate
Sulfur (powder)
Combustion spoon
Nylon stocking (square of material)
Bean sprout
Marble chip (calcium carbonate)
Blue litmus paper
Forceps



STUDENT ACTIVITIES:

1. Fill the combustion spoon with the powdered sulfur. Place about 50 ml of water in one of the glass bottles. Cover both bottles with glass plates. Ignite the sulfur and then place it quickly into the bottle without the water. Let the sulfur burn for several minutes until combustion ceases. Take a piece of litmus paper and place it inside the bottle atmosphere using the forceps. Do not allow the atmosphere to escape, replace the glass cover plate quickly. Note any changes to the litmus paper and record your observations. Next use your forceps to lower the square of nylon into the atmosphere. Leave the material for several minutes, remove it and then observe any changes. Record your observations. Finally with the bottle containing no water, invert the jar to cover the bean sprout and make observations every two minutes.
2. Fill the combustion spoon once again with powdered sulfur and ignite it. Lower the burning sulfur into the bottle with 50 ml of water in the bottom and allow the sulfur to burn for several minutes until combustion ceases. As soon as the sulfur ceases burning remove the combustion spoon and shake the bottle vigorously keeping the glass cover plate over the opening. Take a piece of blue litmus paper and transfer a drop of the solution to the paper. Note and record any changes in the paper. Compare this litmus paper with the litmus paper in part 1. Remove several drops of the solution and place it on the marble chip. Record your observations.
3. Post lab Discussion: Your instructor will discuss the reasons for changes you observed.

V. IDEA A-2

TEACHER MATERIALS

CONCEPTUAL THEME: V

Man's society is an interaction of custom, rule and law.

IDEA A:

Each individual has a vital role in helping maintain the environment so that it is suitable for all forms of life, including man.

BACKGROUND INFORMATION:

The apparatus may be set up to be done one at a time, or if equipment is available, the class may be divided into groups.

Data may be gathered and depending upon class level, graphed according to various groups. (Smokers, non-smokers; heavy smokers, light smokers, etc.) Criteria for research groups may be decided by the class or teacher. Honesty should be stressed for accurate data.

A copy or synopsis of the Fourteenth Amendment in conjunction with question C is helpful and interesting.

PROCESSES OR ACTIVITIES:

Measuring
Graphing
Discussion
Value clarification

STUDENT OBJECTIVES:

1. Measurement of vital lung capacity
2. Awareness of effects of pollution within the organism
3. Arouse interest in laws dealing with pollution and individual rights.

V. IDEA A-2

STUDENT MATERIALS

"BLOW YOUR TOP"

PROBLEMS:

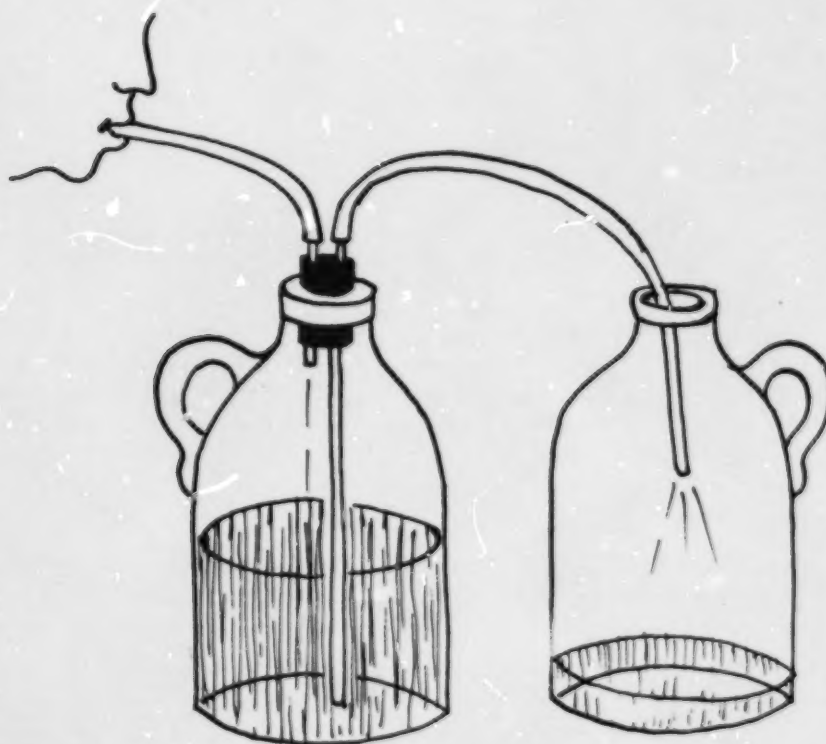
Does smoking affect lung capacity?

MATERIALS:

Two 1 gallon glass jugs
One 2 hole rubber stopper to fit 1 jug
Two pieces of glass tubing to fit stopper holes
(one about 8 cm, one long enough to extend 3 cm above the top of the stopper to the bottom of the jug)
Two pieces of rubber tubing 30 cm long
One graduated cylinder - 100 ml or larger

STUDENT ACTIVITIES:

1. Set up apparatus as drawn.



Completely fill the stoppered jug with water.

2. Now test your vital lung capacity:

Take a deep breath.

Hold your nose with one hand and blow into the rubber hose as shown above.

3. Measure the volume of air you exhale:

Pour the water from the second jug into the graduate.
Record this volume.

4. Repeat this twice and average the three volumes.

5. Record all class data for smokers and non-smokers as instructed by your teacher.

6. Discuss the following questions:

A. Does the amount of smoking affect lung capacity?

B. Is there a difference in results among those who have smoked a long time and those who have recently started?

C. In view of these results, discuss the question of one's rights to smoke up the air of a non-smoker.

VI. IDEA A-1

TEACHER MATERIALS

CONCEPTUAL THEME: VI

The economy and life style of a society results from the individuals' attitudes towards technology and the use of natural resources.

IDEA A:

The world's resources are limited, but the demands for these resources may be unlimited.

BACKGROUND INFORMATION:

One discussion topic everyone has an opinion about is nuclear energy and specifically its use in reactors to produce electrical energy. Despite objections there are two power plants operating in the state of Florida with amazing safety records. The Turkey Point plant near Miami has been in operation for several years and the Crystal River plant will be in full operation soon.

There is no problem finding written material "pro" or "con" the use of nuclear energy; the problem is weeding through this mass of printed material for significant articles. Ask your students to find articles with data to back up the statements made in the articles and to identify the articles source. Good arguments can be made for and against nuclear energy; you might want to do some reading before making this assignment.

After the debate is over you might list the "pros" and "cons" of nuclear energy on the blackboard. Then it would be interesting to see how many students are for or against nuclear energy. In addition check to see how many minds were changed by the research and discussion.

PROCESS OR ACTIVITY:

Communicate, report, interpret.

STUDENT OBJECTIVES:

1. Research and discuss the safety and practicality of using nuclear energy to generate electrical power.
2. Inform students to aid them in making an intelligent decision about a controversial subject.

VI. IDEA A-1

STUDENT MATERIALS

PROBLEM:

Is nuclear energy safe now for electrical power generation?

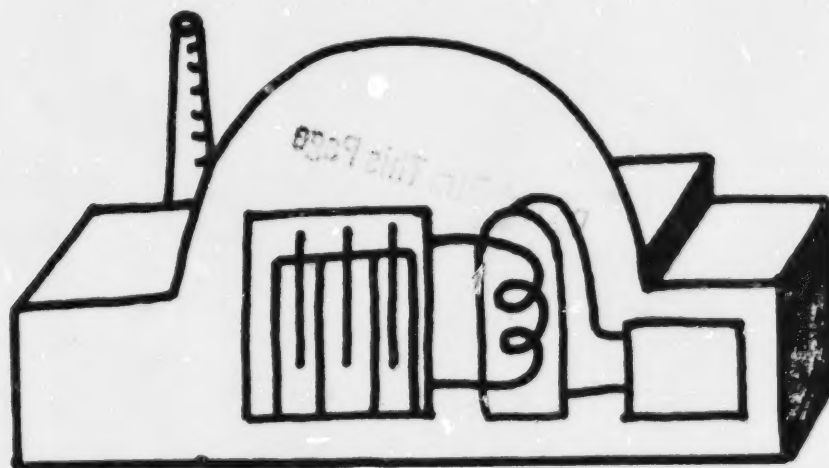
MATERIALS:

Newspapers
Magazines
Pamphlets

STUDENT ACTIVITIES:

1. Decide if you are "pro" or "con" nuclear energy use in the generation of electricity.
2. Research your topic by reading at least one current article supporting your point of view. Summarize the article on the front of a 5" x 8" index card and on the reverse side list the points supporting your point of view present in that article.
3. Meet with the part of the class sharing your opinion about nuclear energy and compare ideas. Elect a group spokesman and then help compose an opening statement which lists the main points supporting your point of view.
4. Debate:

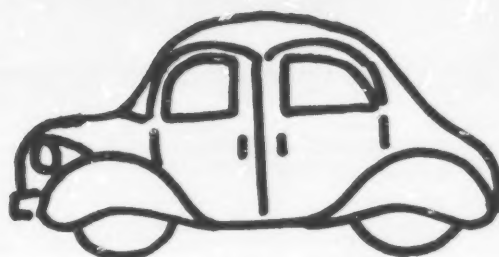
Your teacher will set up rules for the class debate. Remember if you have some evidence to support that statement.



REACTOR

VI. IDEA A-2

STUDENT MATERIALS



PROBLEM:

Search for alternative fuels to gasoline for our existing automobiles.

MATERIALS:

Newspapers
Magazines
Books

STUDENT ACTIVITIES:

1. Decide on a fuel suitable for our modern automobiles that could replace gasoline. Here are some suggestions:
 - A. Compressed hydrogen
 - B. Compressed methane
 - C. Methyl alcohol
2. Research your fuel possibilities and see if any work has been done to convert that fuel for use in the present internal combustion engine. If modifications are needed to the automobile make sure they are included in your report.
3. Prepare a report with diagrams on poster board explaining how the fuel could be stored and used practically. This diagram should start with the raw material and follow it through to its use in the automobile engine.
4. Your instructor will assign a day for reports to be presented to the class. Your report should include:
 - A. A written report with references.
 - B. A poster or diagrams explaining the feasibility of this fuel's production and use. (optional)
 - C. A model of the engine if it must be modified, explaining the changes to be made. (optional)
5. Discussion of Debate:
 - A. After everyone in the class has had an opportunity to present their report, your instructor will lead the class in a discussion listing the good and bad points of each alternate fuel suggested.
 - B. Another idea is to have your class divided into groups that support the use of various fuels and conduct a debate.

VI. IDEA A-2

TEACHER MATERIALS

CONCEPTUAL THEME: VI

The economy and life style of a society results from the individuals attitudes toward technology and the use of natural resources.

IDEA A:

The world's resources are limited, but the demands for these resources may be unlimited.

BACKGROUND INFORMATION:

The gasoline shortage in 1974 should still be fresh in our memory. Gasoline is the present fuel for our automobiles, but for how long? A search for alternate fuels is well underway and research has begun on many alternatives that could be used in our present automobiles. Since high school students are just getting their drivers licenses and have paid for several tanks of gasoline, the topic becomes an interesting one. Some of the most practical research with the substitute fuels has been reported recently in "Popular Science" magazine.

Students can present their articles in a report as suggested in the student activities, but often this is time consuming and many of the articles will be repetitious. A debate is a convenient solution. Students with similar reports can consult and present one total statement about their alternate fuels. After brief reports from each group chairman, a debate can be held to discuss the good and bad points about each suggestion.

PROCESS OR ACTIVITIES:

Communicate, report, interpret, discuss

STUDENT OBJECTIVES:

1. Research and discuss the use of alternate fuels in the modern internal combustion engine.
2. Compare and contrast different fuels that are possible alternate sources of energy for automobiles.

REFERENCES:

Current editions of "Popular Science"

VI. IDEA A-3

TEACHER MATERIALS

CONCEPTUAL THEME:

The economy and life style of a society results from the individuals' attitudes towards technology and the use of natural resources.

IDEA A:

The world's resources are limited, but the demands for these resources may be unlimited.

BACKGROUND INFORMATION:

The main purpose of this exercise is to point out the possible uses of alternate energy forms in our homes. The assignment should inspire students to create a unique home design and at the same time provide familiarization with the latest technology of alternate energy forms.

The best reference material for this assignment may be found in POPULAR SCIENCE MAGAZINE. Other magazines available with pertinent articles would include: SCIENTIFIC AMERICAN, CHEMISTRY, and SCIENCE NEWS. Another source may be found with resource persons. Dr. Erich Farber at the University of Florida is one of the nation's best known solar energy research directors. He has written several articles for magazines on research in this field and has constructed a working solar home in Gainesville, Florida. This solar home was featured in POPULAR SCIENCE magazine recently.

The project can be a main source of classroom discussion topics. Alternate Fuels, Solar Energy, Use of Nuclear Power to Generate Electricity, and Fuel Conservation are just a few of the many possible topics.

PROCESS OR ACTIVITY:

Communicate, report, interpret

STUDENT OBJECTIVES:

1. Research and discuss the feasibility of using various alternative (to petroleum) energy sources in a home design.
2. Research and discuss the use of energy saving devices in a home design.
3. Apply the research concerning energy to the design of a home of the future utilizing existing or newly developed technology.

VI. IDEA A-3

STUDENT MATERIALS

PROBLEM:

Design your own home of the future to include preparation of new forms of energy.

MATERIALS:

Newspapers
Magazines
Pamphlets
Poster Board
3" x 5" cards

STUDENT ACTIVITIES:

Your task is to design your dream home of the future, keeping in mind that in the future, energy sources will be less abundant. Incorporate into your home design as many energy saving and alternative energy sources as would be feasible in your geographic area. The following is a list of suggestions to help you complete your project.

1. Your teacher will give you a list of references of magazine articles, pamphlets and newspaper articles that will help you design your "dream" home of the future. Don't forget to design your home with all the energy saving features and alternate energy sources feasible. Here are some specific areas in the home that must be considered in the total energy plan:
 - A. Heating and Cooling of your home
 - B. Building Materials and Insulation for your home
 - C. Appliances for your home
 - D. Water Conservation devices for your home
 - E. Electrical Conservation devices for your home
2. Petroleum based energies may disappear in the next few years and several alternate energy forms have been suggested. These suggested forms of alternate energy sources will become important in designing a home of the future. Some of these energy sources include:
 - A. Hydrogen Gas
 - B. Methyl Alcohol
 - C. Methane Gas

VI. IDEA A-3

- D. Steam Power (Generated by the combustion of wood, methyl alcohol, methane or another source of alternate energy)
 - E. Solar Power
 - F. Wind Power
 - G. Geothermal Power (If found in your area)
3. Begin your project by identifying several printed resource articles that introduce you to new energy forms and devices utilizing these energy innovations. Summarize these articles on a 3" x 5" card and complete at least 10 articles before beginning your home design.
 4. Draw your home of the future design on a piece of poster paper being careful to explain where you have included the use of alternate energy forms.
 5. If time permits, your teacher will ask you to construct a model of your "dream" home from balsa wood. This project will be a big one and should include completed plans before you begin. Your teacher will give you specific instructions on how to take your drawing and turn it into a three dimensional model.

VI. IDEA C-1

TEACHER MATERIALS

CONCEPTUAL THEME:

The economy and life style of a society results from the individuals' attitudes toward technology and the use of natural resources.

IDEA C:

Natural resources and ecological systems have specific capabilities and limitations.

BACKGROUND INFORMATION:

This may be done as a class demonstration or in groups. It may be used to introduce intraspecific competition, demonstrate carrying capacities, or define density. It will take about two weeks to complete the activity.

Radish seeds may be used (they are much faster) but must be planted in greater quantity or in a smaller area.

PROCESSES OR ACTIVITIES:

Measuring
Observing
Gathering and recording of data

STUDENT OBJECTIVES:

Appreciation of the struggle of intraspecific competition.

VI. IDEA C - 1

STUDENT MATERIALS

"HOW MANY BEANS IN YOUR GARDEN GROW?"

PROBLEM:

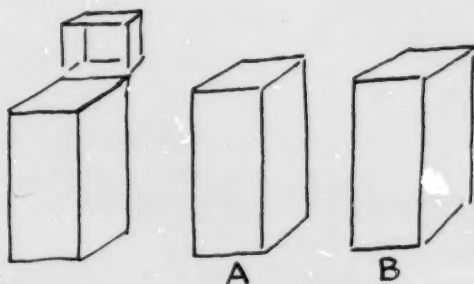
Do organisms compete for space and resources?

MATERIALS: (per group)

2 $\frac{1}{2}$ gallon milk cartons
25 bean seeds (radish seeds may also be used)
Graduated cylinder
Soil and water

STUDENT ACTIVITIES:

1. Cut the tops of the cartons off so you have 2 boxes about 15 cm high. Discard the tops. Label your boxes A and B.



2. Fill each box about $\frac{3}{4}$ full with soil.
3. In the box marked A, plant 5 bean seeds about 3 cm from each other and from the edges.
4. In the box marked B, plant 20 bean seeds evenly spaced.
5. Place both boxes in an area where they receive sunlight.
6. Water the boxes when they start to feel dry. ALWAYS measure the water and give each box equal amounts every time you water them.
7. Keep a daily record of:

- a. the amount of water used
- b. the number of sprouts
- c. the height of the sprouts
- d. any other observations of your plants

After two weeks answer these questions:

- 1. What have you observed as the plants grew?
- 2. What differences can be seen between the two boxes?
- 3. What substances have the plants used in growing?
- 4. Which plants appear to be the strongest? Why?
- 5. How do the plants compete for survival?
- 6. How can this investigation be compared to a crop? A forest?

VOCABULARY

abiotic	Everything that is not living or has never lived in the environment.
adaptation	The way an organism becomes better suited for its environment.
air pollution	The adding of contaminants in the air which interfere with man's health, safety or comfort.
algae	The simplest green plants.
amphibian	A vertebrate with moist skin, early life in water, adult on land.
artificial selection	Man's selection of organisms with characteristics he wishes to improve.
atmosphere	The layer of gases around the earth.
bacteria	Microscopic, single cell organisms.
biodegradable	Capable of becoming broken down (decomposed) by organisms.
biome	Large land areas with similar organisms (biotic) and physical environment (abiotic).
biosphere	The living part of the earth.
biotic	Everything that is living or was recently living.
botany	The study of plants.
carnivore	A meat eating animal.
chlorophyll	The green pigment (color) of a plant that captures the sun's energy (light) for photosynthesis.
classify	Grouping according to likeness or similarity.
climax	The final stage of community succession.
commensalism	A relationship in which one organism is benefited and the other is not affected.

community	All the plants, animals and decomposers in a given area.
competition	Two organisms trying to receive benefit from the same source.
conservation	The wise use and protection of natural resources.
consumer	An organism which feeds on other organisms.
decibel (dB)	A unit of sound measure.
decomposer	An organism such as bacteria, fungus, yeast or mold that breaks down dead organisms into simpler forms.
density	The number of individuals in a given area.
diatoms	Microscopic algae with glass shells that store their food as oil and produce 65 to 90% of atmospheric oxygen.
ecology	The study of the relationship of living things to each other and to their environment.
ecosystem	A community of living things which interact with each other and their biotic environment.
effluent	Wastewater discharge.
energy	The ability to do work.
environment	Everything outside an organism.
eutrophication	The aging process of lakes caused by the decay of growth of plant and animal life.
food web	A combination of interconnected food chains.
fossil	Any evidence of former life.
fossil fuel	Coal, oil, natural gas, derived from ancient plants and animals.
frond	Divided leaves of ferns and palms.
fungi	A decomposer or parasite.

geology	The study of the earth
greenhouse effect	The increase in atmospheric temperature due to an increase in carbon dioxide in the atmosphere.
habitat	The place where a plant or an animal lives.
hammock	A growth of similar hardwood trees (oaks, hickory, gum, elm, maple) in a fertile area; an island of trees.
herbivore	A plant eater.
host	The organism on or in which another organism lives.
humus	Organic material in the soil.
hydrology	The study of water.
hydrosphere	The liquid part of the earth's surface.
indicator species	An organism which is typical of a set of environmental conditions, both biotic and abiotic.
insecticide	A chemical used to kill insects.
instrument	A device for extending the senses.
interdependent	Relying upon one another.
inversion	An atmospheric condition in which a layer of cold air is trapped below a layer of warmer air.
invertebrate	An animal without a backbone.
lichen	A plant consisting of a fungus and algae growing together.
life cycle	The stages or phases through which an organism passes during its lifetime.
limestone	Sedimentary rock composed of the remains of organisms which lived in water.
limnology	The study of fresh water.
littoral zone	The light penetration zone in a body of water.

mammal	An animal which has hair, feeds its young milk, and has a constant body temperature.
microscope	An instrument which magnifies small objects.
monitor	A continuous check of a particular condition.
mutualism	A beneficial relationship between two organisms.
natural resources	A source of wealth provided by God.
natural selection	The survival and reproduction of organisms that are better suited to their environment.
niche	The "job" a living thing does; its relation to its environment; <u>how</u> it lives.
noise pollution	An undesired sound.
nutrient	A substance necessary for growth.
omnivore	An organism which eats anything.
organism	Any living thing.
parasite	An organism that receives its nourishment from another living organism.
pollution	The presence of any undesirable substance in the environment.
producer	A green plant which uses the sun's energy to produce food.
recycle	The process by which waste materials are transformed into new, useful products.
reforestation	Seeding or planting forests again.
reptile	A cold blooded animal with scales and lungs--alligators, snakes, etc.
runoff	Water running on the surface that is not absorbed by soil.

sanitary landfill	A method of burying solid waste between layers of soil.
scavenger	An organism that eats the remains of dead organisms it did not kill.
sediment	Soil particles moved by water - a product of erosion
smog	A mixture of fog and smoke and/or chemical fumes.
soil	The upper layer of earth.
solar energy	Energy from the sun in the form of heat, light, ultra-violet, infra-red, x-ray, radio, etc.
species	A natural population of interbreeding organisms in nature.
spectroscope	An instrument to separate light into its parts.
succession	The orderly change of one biotic community to another.
succession primary	The development of a community in an area that has never before had life on it.
succession secondary	Development of a new community on an area that had its previous community destroyed.
symbiosis	An association between members of two species living together, which could benefit or harm one or both.
symbol	A figure or letter used to represent something else.
temperature	A measure of heat.
thermal pollution	Heat pollution of air or water.
toxic	Poisonous
transpiration	The release of moisture by plants into the air.
trash	Discarded natural or man-made objects.
ultraviolet	High energy, short wave radiation.
vertebrate	An animal with a backbone.
water cycle	The movement of water from the atmosphere to land to oceans and back to the atmosphere.

water
pollution

The addition of undesirable materials in water.
These materials may be man-made or natural.

watershed

All the land that drains into a single stream.

wildlife

Living creatures - animals, fish, reptiles, birds
that are not domesticated.

zoology

The study of animals.